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THE

WORKS

OF

FRANCIS BACON,

BARON VERULAM, VISCOUNT ST. ALBAN, AND LORD HIGH CHANCELLOR OF ENGLAND.

VOLUME THE FOURTH.

CONTAINING

NOVUM ORGANUM SCIENTIARUM.

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PREFACE.

As the following Work appears to have been the least read of all the Author's Writings, though in itself of great importance; it is agreeable to our intention of facilitating the understanding of his Philosophical Works in general, to have a particular regard to the facilitating of this. It seems, therefore, proper to give here, by the way of preparative, First, a short analytical view of the entire plan, and design of the Work; and, Secondly, the rules by which the Author seems to have proceeded in it.

The design of the Novum Organum, *was to advance a more perfect method of using the rational faculty, than men were before acquainted with; in order to raise and improve the understanding, as far as its present imperfect state admits; and enable it to conquer and interpret the difficulties and obscurities of nature.*

With this view it undertakes the care and conduct of the understanding; and draws out and describes the apparatus and instruments that conduce to the true forming, modelling, and applying the power of reasoning: whence it appears to endeavour at a new kind of Logic, *though greatly superior to the common, which, through the abuses crept into it, appears fitter to corrupt than strengthen and improve the mind. For*

the scope and use of this new Logic, is not to discover arguments and probable reasons, but arts and works.

It is divided into two principal parts; viz. *a preparatory part, and one that is* scientificial *and* instructive. *The first part tends to prepare and purge the mind; and fit it to receive and use the instructions and instruments laid down in the second: the mind, like a mirror, requiring to be levelled and polished, or discharged of its false imaginations and perverted notions, before it can be set to receive and reflect the light of truth and just information.*

And this levelling part is of four kinds, with respect to the four different sorts of Idols, *or false notions, that possess the mind. These* Idols *are either acquired or natural; and proceed either from the* doctrines *and* sects *of philosophers, the perverted and corrupt laws and methods of demonstration; or else are innate and inherent in the very constitution of the mind itself. The first labour, therefore, is to discharge and free the mind from its swarms of false theories, which occasion such violent conflicts and oppositions. The next point is to release it from the slavery of perverted demonstrations. And the last is, to put a check upon this seducing power of the mind; and either to pluck up these innate* Idols *by the root; or, if that cannot be done, to point them out, that they may be thoroughly known and watched; and so have the depravities, which they occasion, corrected. This levelling part, therefore, is performed by three kinds of* Confutation; *viz. the* Confutation of Philosophies, *the* Confutation of Demonstrations, *and the* Confutation of the natural unassisted Reason.

When thus the mind is rendered equable and unbiassed, the work proceeds to set it in a proper situation, and, as it were, with a benevolent aspect to the remaining instructions; whereby the business of preparing the mind is still further

carried on. And the whole drift of this ensuing part, is only to possess mankind with a just opinion of the whole Instauration *for a time, that they may wait with patience the issue and event thereof; upon solid assurances of some considerable benefit and advantage from it, when its scope shall come to be well understood. And thence it proceeds distinctly to obviate all the objections, and false suspicions, which may be raised about it, through the prevailing notions and prejudices drawn from religious considerations, those of abstract speculation, natural prudence, distrust, levity, &c. Thus endeavouring to pacify and allay every wind of opposition.*

To render this preparation still more complete and perfect, the next thing is to raise the mind from the languor and torpidity it may contract from the apparent miraculous nature of the thing. And as this wrong disposition of the mind cannot be rectified without the discovery of causes, the work proceeds to mark out all the impediments which have hitherto perversely retarded and blocked the way of true philosophy; and thus makes it appear no wonder at all, that mankind should have been so long entangled and perplexed with errors.

When the ways of removing these impediments are shewn, there follows a chain of arguments for establishing a solid foundation of hope for the better success of genuine and serviceable philosophy in future. For it is hereby demonstrated, that though the interpretation of nature, *intended by the* Instauration, *may indeed be difficult; yet much the greater part of the difficulties attending it are in the power of man to remove, as arising from the nature of the senses, and things themselves; but only require that the mind be rectified in order to their removal. And this first* general part *concludes with an account of the excellence of the end in view.*

The preparatory part being thus dispatched, the work proceeds to the business of information, the perfecting of the un-

derstanding, and the delivery of the art of working with this new machine *in the* interpretation of nature. *This is laid down in three several branches, with regard to the* sense, *the* memory, *and the* reason; *each whereof is assisted in its turn.*

The assistance afforded to the sense shews these three things; viz. 1. *How a* just notion *may be formed; and how the report of the senses, which is always respective to man, may be rectified, and made correspondent, or set to the truth of the universe: for no great stress is laid upon the immediate perceptions of the sense; but only so far as they manifest the motion or alteration of things.* 2. *How those things which escape the senses, either through the subtilty of their wholes, the minuteness of their parts, the remoteness, slowness, or velocity of their motion, the familiarity of the object, &c. may be brought to the senses, and submitted to their judgment: and in case they cannot be thus rendered sensible, what is to be done; and how the senses are to be assisted upon this failure, either by instruments, or skilful observations of the degrees they act in, the indications of proportionate bodies, from such as are sensible to such as are insensible, or by other means and contrivances to help the senses.* 3. *The ways are shewn of compiling a* history of nature, *and engaging in the business of experiments; what that history of nature should be, which is required for the building up of philosophy; and again, what kind of experiments should be gone upon where that history proves deficient: and here certain suggestions and cautions are occasionally interspersed, for raising and fixing the attention; as much matter seems to be already contained in natural history; and as experiments long since known, are not yet brought into use, through inattention of mind. And thus the senses are provided for, as they require matter and assistance: for* history *and* experiments

supply the matter; substitutions supply the defects; and rectifications correct the errors of the senses.

The memory *is assisted in such a manner, as shews how, from a multitude of matters, and a confused heap of natural history in general, particular histories may be deduced, ranged, and disposed; so as that the judgment shall act with freedom, and perform its office to advantage: For a sober estimation must be made of the powers of the mind, without hoping that they may extend to the infinity of things; as it is manifest that the memory is unable to comprehend and retain any vast number of particulars; or to suggest all those that belong to any particular enquiry. A remedy is proposed for the first defect by this rule,* That no enquiry or discovery be trusted but in writing; *though this alone is not sufficient, unless the matter be thrown into a* regular table, *at once to assist both the memory and the reason.*

And after the subject of an enquiry is fixed upon, well defined, distinguished, separated from the mass of other things, and set in a clear light, there are three assistances afforded the memory. The first is, to shew what matters those are which ought to be enquired into with relation to the subject proposed; or to suggest particular heads of enquiry, from a survey of the history of nature. The second is, to shew in what order the things themselves are to be ranged and digested into tables; *though this without expecting to hit upon the true order of things originally established in nature: for the division here proposed is arbitrary; and only serves to make some separation of things, that the mind may act upon them: as truth will easier rise from falshood than from confusion; and as reason may easier correct a division than enter the mass of a subject at once. The third assistance, is to shew by what means, and at what times, an enquiry is to be renewed; and how the preceding* tables *are to be transposed and formed*

into fresh ones; and how often the enquiry should be repeated: for the first, or even the second set of tables are not to stand; as being no more than essays or first attempts towards an enquiry. This general assistance, therefore, to the memory, consists of three points, or regards; 1. *The Heads of Enquiry;* 2. *the forming of Tables; and* 3. *the renewing of the Enquiry.*

Assistance is next afforded to the Reason; *for though the former assistances have regard thereto, yet those of themselves do not teach how to form* Axioms; *but only distinct notions, and a digested history. And here that assistance to the reason is most desirable, which best fits it for performing its office, and obtaining its end.*

The operation of the reason, though but one thing in itself, is yet double in its end and use: for the end of man is either knowledge and contemplation, or action and execution; so that he desires either to know and consider causes; or to have a power and opportunity of producing effects. Whence it is the intention of human knowledge to understand the causes of an effect, or nature assigned, in any subject; and the intention of the human power to procure, or superinduce, within all possible limits, any effect, or nature, upon a given basis of matter.

But these two intentions, if duly considered, come in effect to one and the same thing: for that which in contemplation holds the place of the cause, holds, in operation, the place of the means; since we understand by causes, and operate by means. So that if all the means requisite to the production of every work were ready at the call of man, there would be no occasion for treating these two separately. But men's power in operating is confined to much narrower bounds than their knowledge; by reason of their various necessities and wants: whence they frequently require to the operative part, not a

general and open knowledge, so much as a prudent, ready. and well-versed sagacity in the choice of such things as they have at hand; on which account it might seem proper to treat the theory and practice separate, were it not for the pernicious and inveterate custom of running into abstract notions, which makes it necessary to join them together; and accordingly the Author mixes the contemplative with the executive part. The Contemplative Part *is shewn to consist wholly in one thing, which is no other than the forming of just* Axioms, *or chains of* Axioms, *which are solid portions of truth; as if they had all three dimensions: whereas simple notions are, in comparison with them, but as surfaces And there is no other way of drawing, and raising these* Axioms, *but by a legitimate and proper form of Induction; capable of breaking and separating experience; and concluding of necessity, after all the proper rejections and exclusions are made. For it is manifest, that whatever is concluded by* Induction *of any kind, is at the same time both discovered and judged of; and does not depend upon principles or mediums, but stands entirely upon its own foundation, without farther proof or support: much more must* Axioms, *raised by a true and legitimate form of* Induction, *subsist from within themselves; and prove more solid, just, and certain, than even those called principles. The Author, therefore, is extremely solicitous to deliver, with diligence and perspicuity, this whole affair of* Induction, *or the doctrine of raising* Axioms.

There are found to be three things of capital importance in this business of Axioms; *and without an explanation whereof, the enquiry proposed, though excellent in itself, might yet be thought tedious and operose in use. These three things are the method of* 1. *continuing,* 2. *varying, and* 3. *contracting an enquiry; so that nothing in the whole procedure may be left abrupt, contradictory, or be protracted too*

long, with respect to the shortness of life. The use of the Axioms *discovered by legitimate Induction is, therefore, next taught; so as by their means to investigate and raise up others, of a higher and more general nature; till, by sure, and uninterrupted steps, men come, without stop or gap, to the top-round, or unity of nature; there being, at the same time, added, a way of examining and verifying these higher* Axioms *by* primary experiments; *to preserve them from tumbling back again to conjectures, probabilities, and idols. And this is the doctrine of the* Continuation of Enquiries.

It was before observed, that the practical *or* executive part, *is, by the form of* Induction, *continually intermixed and blended along with the* Contemplative Part: *for the nature of things is such, that Propositions and* Axioms *deduced, by logical arguments, from general principles, and derived down to particulars and works, give but a very obscure and uncertain information: whereas* Axioms, *drawn from particulars, lead on to new particulars, as it were, by a manifest correspondence, and continued thread. And here men are required to remember, that in all active or practical enquiries they must perpetually proceed downward, or in the descending scale, which is of no use or service in contemplative enquiries: For every operation consists in individuals, which are things of the lowest class, and therefore must be descended to by steps from generals. Nor, again, is it possible to arrive at them by simple* Axioms; *for all works, and the methods of working, are performed and laid out from a collection of different* Axioms.

This active or practical doctrine consists of three parts; the first whereof proposes a distinct and proper method of enquiry, where not a cause nor an Axiom, but the effecting of a work, is the point in view, and the subject of the enquiry. The second *teaches a method of making* General Practical

Tables, by means whereof all kinds of plans for works are laid down with greater ease and readiness. The third delivers a certain method of discovering or investigating Works which, though incomplete, has still its uses; as, by means thereof, men may proceed from experiment to experiment, without the raising of Axioms; for as one Axiom leads to another, so likewise there is a certain method of discovery open from one experiment to another; and this method, though uncertain and fallacious, still deserves to be mentioned.

Next are shewn the methods of varying enquiries, both according to the different reasons for which they are undertaken, and the different natures of the things upon which they turn. Where dropping the consideration of final causes, which have entirely perverted natural philosophy; the method of varying, turning, and tabling enquiries is shewn, for investigating the forms, or true peculiar discriminating natures and properties of things, which, till now, was ever looked upon as a desperate and hopeless attempt, as well it might, whilst none but logical arguments, and casual reasonings were employed about it.

The design of the Contraction of Enquiries, is to shew the shortest ways of coming at the things sought for, by cutting across the winding roads that lead to them indirectly. And here things are shewn to have two prerogatives, or extraordinary natures, greatly conducing to the abridgment of enquiries; viz. one which fits them to be produced as instances, and another for being proposed as subjects of enquiry. It is here shewn, therefore, what are the instances, observations, and experiments, that have a prerogative light, or excel others in bringing enquiries to an issue; so that a few of them may serve instead of a larger number, and thus prevent the labour of an extraordinary search, and swelling the bulk of the history. In the last place it is shewn, what those enquiries are which ought to lead the way in the business of interpreting na-

ture, as having a tendency and disposition to give light to all the rest, either on account of their extraordinary certainty, their universal nature, or their usefulness and necessity to mechanic arts, inventions, and new discoveries. And thus the whole is closed with pointing out and directing to leading experiments, and leading enquiries, for a full interpretation and understanding of all nature, and the production of all necessary works and effects.

This is the general scheme of the Novum Organum, *in the execution whereof, the author seems to have proceeded upon the strength and direction of the following Aphorisms, laid down by himself, concerning the qualifications of a just Interpreter of Nature.*

APHORISMS

FOR

A JUST INTERPRETATION OF NATURE.

1. As man is but the servant and interpreter of nature, he can work and understand no farther, than he shall, either in action or contemplation,* observe of the proceedings of nature; to whose laws he remains subject.

2. The limits, therefore, of the human power and knowledge, lie in the qualifications wherewith man is by nature endowed, for acting and perceiving; and again in the state of things presented to him: and beyond these limits his instruments and abilities can never reach.

3. Mens qualifications and endowments, though of themselves but slender, and unequal to the work; yet, when properly and regularly used and applied, are capable of bringing such things before the judgment, and into practice, as lie extremely remote from the ordinary sense and action; and again of conquering greater difficulties in works of obscurities in science, than any one at present knows so much as to wish for.†

4. As truth is but one simple thing; so likewise is the interpretation of nature: but the senses are fallacious, the mind unstable, and the cause pressing; yet the business of interpretation is rather uncommon than difficult.

5. He who is not practised in doubting, but forward in asserting and laying down such principles as he takes to be approved, granted, and manifest; and according to the established truth thereof, receives or rejects every thing, as squaring with, or proving contrary to them;‡ is only fitted to mix and confound things with words, reason with mad-

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* *Viz.*—In what we vulgarly call theory and practice.

† We have many instances hereof in mathematics, mechanics, astronomy, optics, acoustics, chemistry, and particularly in the modern mathematical philosophy.

‡ Is not this the manner wherein philosophers generally proceed?

ness, and the world with fable and fiction; but not to interpret the works of nature.

6. He who does not blend together, and bring into a mass, all the vulgar distinctions of things, and their names,* cannot perceive the unity of nature, nor observe the true lines of things; and, of course, cannot interpret.

7. He who has not in the first place, and above every thing else, thoroughly examined the motions of the human mind; and with the utmost accuracy noted, and made a kind of map of the paths of science, and the seats of error therein, will find all things under a mask, or as it were enchanted; and unless he breaks the charm, can never interpret.†

8. He who only is versed in discovering the causes of obvious and compounded things, such as flame, dreams, fevers, &c. but has no recourse to simple natures; and first to those that are such in popular esteem; then to those which are artificially reduced, and as it were sublimed to a truer simplicity; may perhaps, if he otherwise errs not, make some tolerable additions (bordering upon discoveries) to the things already known: but will have no success in conquering the inveterate and general prejudices of the age; and cannot be called an interpreter.‡

9. He who would come duly prepared, and fitted, to the business of interpretation, must neither be a follower of novelty, custom, nor anti-

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* *Viz.*—He who does not obliterate, or as it were annihilate, in his mind the vulgar notions and terms, which are seldom just, precise and adequate, cannot perceive the harmony and consent of things; nor observe their true differences, or lines of separation; after the manner that one country is distinguished and separated from another in maps.

† He who does not understand mens' prejudices, opinions, kinds and degrees of knowledge, errors, &c. can never remove, alter, improve, or redress them; and unless he finds a way of entering and convincing the mind of its errors, false notions, superstitions, and delusions, he can never greatly improve and increase the mass of sound and serviceable knowledge.

‡ The modern improvements in the subject of light, may illustrate this aphorism: for till light was analized, or resolved, from its naturally compounded state, into simpler parts, or rays of different colours; no very great discovery was made therein. So that Sir Isaac Newton, in this respect, may be called the interpreter; and be said to have conquered the prejudices that formerly prevailed about the doctrine of light.

quity; nor indulge himself a liberty of contradicting; nor servilely follow authority. He must neither be hasty in affirming, nor loose and sceptical in doubting; but raise up particulars to the places assigned them by their degree of evidence and proof. His hope must encourage him to labour, and not to rest; he must not judge of things by their uncommon nature, their difficulty, or their high character; but by their just weight and use. He must, in his own particular, carry on his view with concealment;* and yet have a due regard for posterity. He must prudently observe the first entrance of errors into truths, and of truths into errors; without despising or admiring any thing. He must understand his own talents and abilities, or the advantages of his own nature. He must comply with the nature of others. He must, as with one eye, survey the natures of things, and have the other turned towards human uses.† He must distinctly understand the mixed nature of words; which is extremely capable both of prejudicing and assisting. He must lay it down to himself, that the art of discovering will grow up, and improve, along with discoveries themselves. He must not be vain either in delivering or concealing the knowledge he has acquired; but ingenuous and prudent; and communicate his inventions without pride or ill-nature: and this in a strong and lively manner, well defended against the injuries of time, and fit for the propagation of knowledge, without occasioning errors; and, which is the principal thing of all, it must be such as may select and chuse for itself a prepared and suitable reader.‡

10. The interpreter thus qualified, should proceed in this manner. He must first consider the state of mankind; next remove the obstacles in the way of his interpretation; and then, coming directly to the work, prepare a history and regular sets of tables of invention; shew the uses thereof, their relations, dependencies, and subserviency to each other. He must represent how little real and serviceable knowledge mankind is possessed of; and how all just enquiry into nature has been neglected. He must use choice and judgment in singling out and giving the first place to such subjects of enquiry, as are most fundamental or important; that is, such as have a principal tendency to the discovery of other things,

* The author explains the meaning hereof, so far as he thought necessary, under Part I. Sect. VII. of the following work.

† *Viz.*—The uses of life, and the service of mankind in general.

‡ If the reader, therefore, should be shocked, disgusted, or unentertained with the following piece, he may please to examine himself, whether he be of the number of those for whom it was designed.

or else to supply the necessities of life. He must likewise observe the pre-eminency of instances; which is a thing that greatly conduces to shorten the work. And when thus provided, he must again renew his enquiries, draw out fresh tables, and now, with a greater ripeness of knowledge, more successfully enter upon, and perfect the business of interpretation: which will thus become easy, and follow, as it were, spontaneously; so as in a manner to be seasonably anticipated by the mind. And when he has done this, he will directly see and enumerate, in a pure and native light, the true, eternal, and most simple motions of nature; from the regular and exact progress whereof proceeds all that infinite variety of the universe. In the mean time, he must not, from the very beginning of the work, omit, with assiduity, to observe and set down, many new and unknown things, for the service of mankind; as it were in the way of interest, till they receive the principle. And afterwards, being wholly intent upon the discovery of human uses,* and the state of things then present, he will regulate and dispose all in a different manner for practice; assigning to the most secret and hidden natures,† others that are explanatory thereof; and such as are superinducing to those that are most absent.‡ And thus at length he will, like another nature, form such general axioms of knowledge, works, and effects, as shall rarely err; and if they should, these errors will appear but as monsters in nature, and yet leave the art, by which they were found, unviolated in its prerogative.

In this aphoristical manner, the author proceeds through the whole of the following work; which is no more than a continued string of aphorisms; or summary expressions of pure matter of science, in simple language, without foreign ornament; and upon the footing of competent experience and observation. Hence aphoristical writings are rich and pregnant things, capable of being unfolded, explained, illustrated, and deduced into great variety. Yet an aphorism differs from an axiom; as a true and perfect axiom is incapable of

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* See above, Aph. 9. † Properties suppose.

‡ *Viz.*—Be enabled to give the properties of one body to another; or introduce properties where they were not: as, to give an incombustible property to wood; inflammability to water; transparency to metals; malleability to glass; the colour and gravity of gold to silver, &c. which present esteemed things either impossible or impracticable.

farther improvement, but an Aphorism still improvable. So that Aphorisms are a kind of imperfect Axioms, that ought to point and lead up to the perfect. And as Aphorisms thus approach to Axioms, we should not despair of raising an Axiomatical Philosophy upon the strength of the following sett.

INTRODUCTION.

1. THEY who confidently or magisterially pronounce of nature, as of a thing already discovered, have highly injured philosophy and the sciences; and had the success, not only to enforce a belief, but to stop farther enquiry.—Others, whether from an aversion to the ancient sophists, instability of mind, or too large a measure of knowledge, assert, that *nothing is knowable*, and produce no despicable reasons for their opinion; though they do not derive it from its true principles: and being carried away with zeal and affectation, they have exceeded all bounds. The ancient Greeks, whose writings are lost, wisely held a middle way, between the arrogance of the former, and the despondency of the latter; and though they were frequently complaining of the difficulty of enquiries, and the darkness wherein things are wrapp'd, yet they kept on their course, though they champed the bit, without losing sight of nature: as if resolved not to dispute, but to try whether any thing were knowable.* Yet even these, using only the effort of the naked understanding, did not apply the *rule*, but placed all things in subtlety of thought, and fluctuation of the mind.

* See hereafter, Sect. IV.

2. The thing we propose, is to settle the degrees of certainty; to guard the sense by a kind of reduction;* generally to reject that work of the mind which is consequent to sense; and to open and prepare a new and certain way for the mind, from the immediate perceptions of the senses.—And thus much was, doubtless, intended by those who have so highly magnified the art of logic: which plainly shews they sought for some assistances to the understanding; and held the natural procedure, and spontaneous motion of the mind suspect. But this remedy came too late, after the mind was possessed, and polluted by customs, lectures, and doctrines; and filled with vain idols,† or false notions.—Whence this superinduction of logic, far from correcting what was amiss, rather fixed the errors of the mind, than opened a way to truth. The only remedy left is, therefore, to begin the whole work of the mind anew; and, from the very first, never leave it to itself; but keep it under perpetual regulation, as if the business were performed by a machine.‡ And, indeed, if men had set about mechanical works, with their bare hands, unassisted with instruments, as they have ventured to set about intellectual works, almost with the naked powers of the mind, they would have found themselves able to have effected very little, even though they combined their forces. If some large obelisk were to be raised, would it not seem a kind of madness for

* Viz. By contriving ways of submitting things, in a proper manner, to the senses; that a true judgment may be formed of them, when thus again brought under view.

† See hereafter, Sect. II. Aph. 37.

‡ Hence we learn the reason of the title, *Novum Organum*; though doubtless the author also intended some allusion to the Organon, or logic of Aristotle.

men to set about it with their naked hands? and would it not be greater madness still to increase the number of such naked labourers, in confidence of effecting the thing? and were it not a farther step in lunacy, to pick out the weaker bodied, and use only the robust and strong; as if that would certainly do? but if, not content with this, recourse should be had to anointing the limbs, according to the art of the ancient wrestlers, and then all begin afresh, would not this be raving, with reason? Yet this is but like the wild and fruitless procedure of mankind in intellectuals; whilst they expect great things from multitude and consent; or the excellence and penetration of capacity; or strengthen, as it were, the sinews of the mind with logic. And yet, for all this absurd bustle and struggle, men still continue to work with their naked understandings. At the same time, it is evident, that in every great work, which the hand of man performs, the strength of each person cannot be increased; nor that of all be made to act at once, without the use of instruments or machines.*

3. Upon the whole, men are to be reminded of two things; (1.) That it fortunately happens, to prevent all controversy and elation of mind, that the ancients will remain undisturbed in the honour and reverence due to them; whilst we pursue our own design, and reap the fruits of our moderation. For if we should pretend to produce any thing better than the ancients, yet proceed in the same way as they did, we could, by no art of words, prevent some ap-

* The foundation of the Novum Organum seems laid in this paragraph; so that if this be not found just, the superstructure must fall of course.

parent rivalship in capacity, or ability: and however allowable this might be, as it is a liberty they took before us, yet we should know the inequality of our own strength, and not stand the comparison. But now, as we go upon opening a quite new way for the understanding, untried and unknown to the ancients, the case changes, and all party and contest drops. (2.) That we are no way bent upon disturbing the present philosophy, or any other that is, or shall appear more perfect: the common system, and others of the same kind, may continue, for us, to cherish disputes, embellish speeches, &c. the philosophy we would introduce, will be of little service in such cases: nor is ours very obvious, and to be taken at once, nor tempting to the understanding, nor suited to vulgar capacities, but solely rests upon its utility and effects. Let there be, therefore, by joint consent, two fountains, or dispensations, of doctrine; and two tribes of philosophers, by no means enemies or strangers, but confederates and mutual auxiliaries to each other: and let there be one method of cultivating, and another of discovering the sciences. And to those who find the former more agreeable, for the sake of dispatch, or upon civil accounts, or because the other course is less suited to their capacities, (as must needs be the case with far the greater number;) we wish success in the procedure, and they may obtain their ends. But if any one has it at heart, not only to receive the things hitherto discovered, but to advance still farther; and not to conquer an adversary by disputation, but to conquer nature by works; not neatly to raise probable conjectures, but to know things of a certainty, and demonstratively; let him, as a true son of the sciences, join issue with us, if he pleases: that, leaving the entrance of nature, which infinite numbers have trod, we

may, at length, pass into her inner courts.* To make ourselves still more intelligible, we shall give names to these two methods of procedure; and familiarly call the first the *Anticipation of the Mind*, and the other the *Interpretation of Nature*.

4. And now, we have only this request to make; that as we have bestowed much thought and care,† not only that what we offer should be true; but also, as much as is possible, that it should be accessible to the human mind, though strangely beset and prepossed; we entreat it, as a piece of justice at the hands of mankind, if they would judge of any thing we deliver, either from their own sense, the cloud of authorities, or the forms of demonstration which now prevail, as so many judicial laws; that they do it not on the sudden, and without attention; but first master the subject; by degrees make trial of the way we chalk out; and accustom themselves to that subtilty of things, which is imprint-

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* Notwithstanding this distinction, the author has been suspected to oppose the ancients: though his design every where is to make use of all the assistance they afford, fit for the purpose; and to advance the whole of philosophy to a greater perfection. But how few helps and materials, for this purpose, are derivable from the ancients, is another consideration. See hereafter Sect. IV. See also hereafter, Aph. 31, &c.

† The author wrote the following work twelve times over, with his own hand; making it a rule to revise, correct, and alter it once a year, till he brought it to the present degree of perfection. And whoever desires to see how far it was, by this means, improved, may compare it with the *Cogitata et Visa*, published by Gruter; which was the rough draught of the first book only, of the Novum Organum; and sketched out, at least thirteen, if not many more, years before the publication of this piece: for Sir Thomas Bodley, in the year 1607, complains of the author for having kept it so long in his coffer.

ed in experience; and, lastly, that by due and seasonable perseverance, they correct the ill habits that closely adhere to the mind: and when thus they begin to be themselves, let them use their own judgment, and welcome.*

* Though this request might be more necessary, at the time the author made it, yet perhaps it is not still unseasonable: for possibly the generality, even of philosophers, are not to this day sufficiently divested of preoccupation, party, and prejudice, to form a true judgment of what the author wrote so long ago.

NOVUM ORGANUM.

PART I.—SECTION I.

GENERAL APHORISMS FOR INTERPRETING NATURE, AND EXTENDING THE EMPIRE OF MAN OVER THE CREATION.

APHORISM I.

MAN, who is the servant and interpreter of nature, can act and understand no farther than he has, either in operation, or in contemplation, observed of the method and order of nature *.

2. Neither the hand without instruments, nor the unassisted understanding, can do much;

* Human knowledge is acquired by observation, and experience; or by conversing with the things about us, through the mediation of the senses, and subsequent reflexion: therefore, the more we observe and try, the more we learn and are enabled to perform. And thus knowledge and power go hand in hand: so that the way to increase in power, is to increase in knowledge. The Europeans exceed the savage Indians in power, by having a superior knowledge of arts, arms, &c. See Aph. 3.

they both require helps to fit them for business; and as instruments of the hand, either serve to excite motion, or direct it; so the instruments of the mind either suggest to, or guard and preserve the understanding*.

3. The knowledge and power of man are coincident; for whilst ignorant of causes, he can produce no effects: Nor is nature to be conquered but by submission†. And that which in speculation stands for the cause, is what in practice stands for the rule‡.

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* This Aphorism in another place is turned thus. "The "naked and unassisted hand, however strong and true, is "adapted only to the performance of a few easy works; "but when assisted by instruments, becomes able to per-"form abundance more, and of much greater difficulty: "and the case is exactly the same with the mind." The whole will be abundantly explained and illustrated by what follows. See also *Introduction*, § 2 and 3.

† *Vis.* By condescending to enquire into, and observe her methods of working; as a servant who would learn of his master. For no power of man can possibly break the chain of natural causes; so that the only method whereby man can rule nature, must depend upon learning her ways

‡ This Aphorism is otherwise expressed by the Author in another place, thus. "The human power has this for its "object; to impose or introduce any nature upon a given "basis of matter, within the condition of possibility; and "the object of the human knowledge is the discovery of "the causes of an effect assigned, in any subject. And

4. In works, men can do no more than put natural bodies together, and take them asunder; all the rest is performed by the internal operations of nature.

5. The mechanic, the mathematician, the physician, the chemist, and the natural magician, are concerned in the works of nature; but, all of them, at present, superficially, and to little purpose *.

" these are two coincident intentions: for what in contem-
" plation is assigned as the cause, is in operation the means
" of producing the effect." And again, thus. " There is,
" in fact, no difference betwixt a theoretical and practical
" proposition: thus to assert that light belongs not to the
" nature of heat, is the same as to assert, that in the pro-
" duction of heat there is no necessity for the producing of
" light." This matter also will be fully illustrated hereafter; though it be indeed self-evident upon a little attention.

* This Aphorism is more fully delivered in another place, thus. " The knowledge of which mankind are hi-
" therto possessed, does not reach to certainty; and the
" production of great effects. Physicians pronounce
" many diseases incurable, and frequently mistake and fail
" in the cure of the rest; the alchemist never relinquishes
" his hopes: the works of the natural magician are unsta-
" ble, and of little advantage: the mechanic arts derive no
" great light from philosophy, and but languidly prosecute
" experiments in low and trivial subjects; so that the dis-
" coveries at present in use are extremely crude, and far
" from perfect."

6. It is madness, and a contradiction, to expect that things, which were never yet performed, should be effected, except by means hitherto untried.

7. The productions of the mind and hands, seem exceedingly numerous in books and works; yet all this variety arises from the particular subtilizing upon, and applying, a few known things, and not from any number of Axioms *.

8. Nay, the works hitherto discovered, are owing rather to accident and trial, than the sciences; which, as they now stand, are nothing but compilements of things found out before, and not methods of enquiry, or plans of new works.

9. The root of all the mischief in the sciences, is this; that falsly magnifying and admiring the powers of the mind, we seek not its real helps.

10. The subtilty of nature far exceeds the subtilty of the sense and understanding; so that

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* Thus the numerous books wrote upon religions, laws, morality, &c. may be reduced back to a few particulars, which gave them origin; and the arts of glass, medicine, the modern art of war, &c. to the casual observation of ashes melted by heat, the accidental discovery of simples, gun-powder, &c. whereas had all these proceeded from the light of Axioms, they would have proved much more perfect, serviceable, and advantageous: But the Axioms are wanting for this purpose.

the sublime meditations, speculations, and reasonings of men are but a kind of madness, if a fit person were to observe them*.

11. As the sciences now in being are useless in the discovery of works, so is the present logic in the discovery of the sciences.

12. The common logic is better fitted to fix and establish errors, which are found in vulgar notions, than for searching after truth; so as to be more prejudicial than useful.

13. Syllogism is not applied to the principles of the sciences, and it is in vain applied to intermediate Axioms†, as being unequal to the subtilty of nature; and therefore catches the assent, but lets things themselves slip through‡.

14. Syllogism consists of propositions, propositions of words, and words are the signs of notions; therefore, if our notions, the basis of all,

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* This Aphorism deserves attention. Certainly, upon examining, every man may find his common notions very inadequate, or far from corresponding even with those he gains by conversing more familiarly and intimately with nature. And yet, after a life spent upon any particular enquiry, in the common method, there still usually remains some subtilty of nature behind, which we cannot catch; and are apt, perhaps wery extravagantly, to guess at. And if this be the case in sensible and material things, what must our general theories and systems be?

† See below, *Aph.* 19.

‡ See the next Aphorism.

are confused, and over hastily taken from things, nothing that is built upon them can be firm; whence our only hope rests upon genuine Induction *.

15. No notion can be safely trusted, either in logics or physics; not even those of substances, qualities, actions, passions, and existence; much less those of gravity, levity, density, tenuity, moisture, dryness, generation, corruption, attraction, avoidance, element, matter, form, &c. but all are fantastical, and ill defined †.

16. The notions of the lower species, as of a man, a dog, a dove, and the immediate apprehensions of sense‡, as heat, cold, white, black, &c. do not greatly deceive us; though these also are sometimes greatly confounded by the flowing in of matter, and the putting of things together. And for all the rest, which mankind have hitherto employed, they are mistaken, or not duly abstracted, and raised from things ||.

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* *Vis.* A competent catalogue of instances, on both sides of the question; so that when all the exceptions are properly made, a sound, or at least a serviceable, portion of truth may be left, as an Axiom, behind. See *Aph.* 105, 106.

† Mr. Locke's Chapter of Ideas, in his Essay upon Human Understanding, is a kind of Comment upon this Aphorism.

‡ Now commonly called Sensations.

|| See Mr. Locke's Essay upon Human Understanding.

17. Nor is there less licentiousness, or fewer mistakes, in the raising of Axioms, than in the forming of notions, and this even in principles themselves, which depend upon the vulgar Induction*; much more in the inferior Axioms, and propositions, deduced by syllogism.

18. All hitherto discovered in the sciences, falls nearly under vulgar notions; but to proceed farther into nature, it is requisite that both notions and Axioms be formed into things, in a surer and more guarded manner; and that a better and more certain way of working with the understanding be introduced.

19. There are two ways of searching after, and discovering truth; the one, from sense and par-

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* The vulgar Induction, to explain it in a familiar manner, is that method of arguing which men use, when they say, *I'll give you an instance;* and then produce a case, or several cases, wherein their proposition holds. And in the same manner, the common Logical Induction proceeds upon an enumeration of particular instances, or examples; but without a due regard to those that may be produced on the contrary, or negative side: so that this Induction is absolutely unsafe and trifling, as being liable to be set aside by the contradictory instances, whenever they shall appear. And this we see frequently happens, both in discourse and writing. What the Author's method of Induction is, may appear from the note upon *Aph.* 14. above; but more fully hereafter, *Aph.* 105, 106. and in the second part of this work.

ticulars, rises directly to the most general Axioms, and resting upon these principles, and their unshaken truth, finds out intermediate Axioms; and this is the method in use. But the other raises Axioms from sense and particulars, by a continued gradual ascent, till at last it arrives at the most general Axioms, which is the true way, but hitherto untried*.

20. The understanding, when left to itself, takes the first of these ways, and prepares it in logical order; for the mind delights in springing up to the most general Axioms, that it may find rest. But after a short stay here, it disdains experience; and these mischiefs are at length increased by logic, for the ostentation of dispute†.

21. The understanding being left to itself, in a sober, patient, and sedate genius, and especially if unprejudiced by any former doctrine, will make some attempt in the second or right way, but to little advantage; for unless regulated and assisted, the understanding is here very unequal,

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* And upon this way it is that the Author rests his greatest hopes of improving philosophy and the sciences. See hereafter, *Aph.* 105.

† There is scarce a more pernicious thing to philosophy, than the common practice of disputing with heat, and a hasty turbulent use of syllogism. These kind of captious and sophistical contests are as the fevers of the reason.

and absolutely unfit to conquer the obscurity of things.

22. Both these ways begin with sense and particulars, and end in the most general principles; but they otherwise differ immensely. The one lightly passes over experience and particulars, which the other duly and orderly dwells on; the former constitutes certain abstract and useless generals from the beginning, but the latter rises gradually to such as nature really acknowledges*.

23. There is a wide difference betwixt the idols of the human mind, and the ideas of the divine mind; that is, betwixt certain vain conceits, and the real characters and impressions stamped upon the creatures, as they are found †.

24. It is impossible that Axioms, raised by argumentation, should be useful in discovering new works, because the subtilty of nature vastly exceeds the subtilty of argument ‡: But Axioms,

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* That is, such as men may safely proceed upon, in producing effects; for being drawn from nature, they readily find the way to nature again, and in this sense are acknowledged by her, as her own.

† See above, *Aph.* 10. Astronomers distinguish betwixt the real and apparent motions of the heavens; the one being respective to man, and the other to the truth; or supposing an observer seated in the centre of the system. This may, perhaps, illustrate the present Aphorism.

‡ To depend upon argumentation, or the common method of reasoning, in physical enquiries, is working only

duly and methodically drawn from particulars, will again easily point out new particulars, and so render the sciences active *.

25. The Axioms in use, being derived from slender experience, and a few obvious particulars, are generally applied in a corresponding manner; no wonder, therefore, they lead us not to new particulars. And if any instance unobserved before happens to turn up, the Axiom is preserved by some trifling distinction, where it ought rather to be corrected †.

26. The natural human reasoning, we for the sake of clearness, call the anticipation of nature, as being a rash and hasty thing ‡; and the reason duly exercised upon objects, we call the interpretation of nature.

27. This anticipation has force enough to procure consent§; for if all mankind were mad, in one and the same manner, they might still agree among themselves.

28. Anticipations, also, have a much greater power to entrap the assent, than interpretations;

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with words and thoughts, where manual operations and experiments are required.

* See above, *Aph.* 22.

† Has not this been generally the case, from the time of Aristotle to the present?

‡ See above, *Aph.* 20. See also *Introduction*, § 3.

‖ Is it not also the chief spring of human actions!

because, being collected from a few familiar particulars, they immediately strike the mind, and fill the imagination; whereas interpretations, being separately collected from very various and very distant things, cannot suddenly affect the mind; whence, of necessity, in difficult and paradoxical matters, these interpretations appear almost like Mysteries of Faith*.

29. In the sciences founded on opinion and decree, anticipations and logic are of great service, where not things, but the assent is to be brought under subjection.

30. But though the labours and capacities of the men in all ages were united and continued, they could make no considerable progress in the sciences, by anticipation; because the radical errors, in the first concoction of the mind, are not to be cured by the excellence of any succeeding talents and remedies†.

31. And it is in vain to expect any great advancement of the sciences, by superinducing or engrafting new inventions upon old: The restoration must be begun from the very foundation,

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* This Aphorism seems capital, or almost Axiomatical: it is made great use of hereafter, and requires to be well remembered.

† Let this Aphorism be well considered; and, if found just, remembered.

unless men chuse to move continually in a circle, without considerably advancing.

32. All the ancient authors will still remain possessed of their honour, and unrivalled in their genius and ability; as we only point out a new path, without censuring their proceedings.

33. No true judgment can, by anticipation, be formed of this new method of ours, nor of the things it discovers; for they cannot, in justice, be tried by the method of reasoning at present used, which is itself called in question.

34. Nor is it an easy matter to deliver, or explain, what we have to produce; because things new in themselves will still be understood from their relation to the old *.

35. Confutations are of no service, where men differ about principles, notions, and the forms of demonstration †; and our desire is not victory, but only to find the minds of men prepared, and capable of receiving what we offer.

36. We have but one simple way left us, and that is leading mankind to particulars, their senses and their orders; whilst they prevail upon themselves to forsake their notions for a time, and begin their acquaintance with things ‡.

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* See hereafter, *Aph.* 109.

† Yet are not most Confutations of this kind?

‡ The things here intended, the Author proposed to select with judgment, as they should appear most useful in

37. Our method has some resemblance with that of the Sceptics, at the entrance, but differs widely from it, and becomes opposite to it, in the end. They simply assert, that nothing is knowable, and we say, that much cannot be known of nature, in the common way; but then they destroy the authority of the sense and understanding, whereas we supply them both with helps*.

SECTION II.

OF THE FALSE IMAGES, OR IDOLS, OF THE MIND.

1. THE Idols †, and false notions of the mind, take such root therein, and so possess it, that truth can hardly find entrance; and even when

themselves, fittest for raising of Axioms, enriching the understanding, &c. and to range them in some proper order, or in the form of regular tables, that the mind might act to advantage upon them, without distraction or confusion.

* This will be explained and illustrated, by a variety of examples, in the Second Part of the Work.

† The Author here seems to have made a happy choice of the word Idol, which elegantly distinguishes false science from true; as erroneous knowledge is a kind of idolatry, or a worship paid to false gods, which is only due to the true One.

it is entered, these will again rise up, and grow troublesome, in the rebuilding of the sciences, unless men guard against them with all possible diligence.

2. There are four kinds of Idols that possess the mind of man. In order to be better understood, we will assign names to them, and call the first kind, Idols of the Tribe; the second, Idols of the Den; the third, Idols of the Market; and the fourth, Idols of the Theatre.

3. The raising of notions and Axioms by legitimate Induction*, is doubtless the proper remedy for removing and driving out the Idols of the mind; yet the Indication of Idols† is a thing of great use, the doctrine of them being to the interpretation of nature, what the doctrine of the confutation of sophisms is to the common logic.

4. Idols of the Tribe have their foundation in human nature, and the whole tribe or race of mankind; for it is a false assertion, that the human sense is the measure of things, since all perceptions, both of the sense and mind, are with relation to man, and not with relation to the universe‡. But the human understanding is like

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* See above, *Aph.* 14.

† *Viz.* The discovering or pointing of them out.

‡ Philosophers should, if possible, conceive of things as they are parts of the universe, and as they have their office

an unequal mirror to the rays of things, which, mixing its own nature with the nature of things, distorts and perverts them*.

5. Idols of the Den, are the Idols of every man in particular†; for, besides the general aberrations of human nature, we every one of us have our peculiar Den or Cavern, which refracts and corrupts the light of nature, either because every man has his respective temper, education, acquaintance, course of reading, and authorities, or because of the differences of impressions, as they happen in a mind prejudiced or prepossessed, or in one that is calm and equal, &c. So that the human spirit, according so its disposition in individuals, is an uncertain, very disorderly, and almost accidental thing. Whence Heraclitus well observes, that men seek the sciences in the lesser worlds, and not in the great or common one.

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and use therein; but men generally consider things only as they have some particular relation to the sense, which cannot possibly discover the systematical or cosmical qualities and uses of things.

* See above, *Aph.* 23. and hereafter, *Aph.* 45.

† The Author, in another place, considers this kind of Idol as every man's particular dæmon, or seducing familiar; and again, he considers every man's mind as a glass, with its surface differently cut, so as differently to receive, reflect, and refract the rays of light that fall upon it.

6. There are also Idols that have their rise, as it were, from compact, and the association of mankind; which, on account of the commerce and dealings that men have with one another, we call Idols of the Market. For men associate by discourse, but words are imposed according to the capacity of the vulgar; whence a false and improper imposition of words strangely possesses the understanding. Nor do the definitions and explanations wherewith men of learning, in some cases, defend and vindicate themselves, any way repair the injury; for words absolutely force the understanding, put all things in confusion, and lead men away to idle controversies and subtleties, without number*.

7. Lastly, there are Idols which have got into the human mind, from the different tenets of philosophers, and the perverted laws of demonstration. And these we denominate Idols of the Theatre; because all the philosophies that have been hitherto invented or received, are but as so many stage-plays, written or acted, as having shewn nothing but fictitious and theatrical worlds. Nor is this said only of the ancient or present sects and philosophies, for numberless other fables, of the like kind, may be still in-

* See Mr. Locke's Essay upon Human Understanding.

vented and dressed up, since quite different errors will proceed from almost the same common causes. Nor, again, do we mean it only of general philosophies, but likewise of numerous principles and Axioms of the sciences, which have prevailed through tradition, belief, and neglect. But these several kinds of Idols must be more fully and distinctly shewn, that the mind may be upon its guard against them.

8. The mind has this property, that it readily supposes a greater order and conformity in things, than it finds; and though many things in nature are singular, and extremely dissimilar, yet the mind is still imagining parallels, correspondencies, and relations between them, which have no existence. Hence the fiction, that all the celestial bodies moved in perfect circles; hence the fictitious element of fire, with its orb, was added to the three sensible elements, to make them four; and such kind of dreams. Nor does this folly prevail only in tenets, but also in simple notions.

9. When the mind is once pleased with certain things, it draws all others to consent, and go along with them; and though the power and number of instances, that make for the contrary, are greater, yet it either attends not to them, or despises them, or else removes and rejects them, by a distinction, with a strong and pernicious

prejudice to maintain the authority of its first choice unviolated. And hence, in most cases of superstition, as of astrology, dreams, omens, judgments, &c. those who find pleasure in such kind of vanities, always observe where the event answers, but slight and pass by the instances where it fails, which are much the more frequent. This mischief diffuses itself still more subtilly in philosophies and the sciences, where that which has once pleased infects and subdues all other things, though much more substantial and valuable than itself. And though the mind were free from this delight and vanity, yet it has the peculiar and constant error of being more moved and excited by affirmatives, than by negatives, whereas it should duly and equally yield to both. But, on the contrary, in the raising of true Axioms, negative instances have the greatest force *.

10. The human intellect is most moved by those things that strike and enter it all at once, so as to fill and swell the imagination; but for the rest, it feigns and supposes them, after a certain imperceptible manner, to be like those few that possess the mind, whilst the understanding is quite slow, and unfit to pass so readily to remote and dissimilar instances, whereby Axioms were

* As will be more fully shewn hereafter. See *Part* II. *Sect.* II.

tried, as it were, in the fire*, unless the task be imposed upon it by severe laws, and a potent authority.

11. The human understanding shoots itself out, and cannot rest; but still goes on, though to no purpose. Thus it is inconceivable there should be any bounds to the universe; yet it constantly, and, as it were, necessarily recurs, that there must be something farther. So, again, it cannot be conceived how eternity should have flowed to the present time; and there is the like subtilty as to the infinite divisibility of lines, &c. all arising from the weakness of human thought. But this impotence of the mind proves more pernicious in the discovery of causes; for although the highest universals in nature, ought to be positive things, because they are found, and cannot be made, yet the understanding, not knowing how to stop, is still desirous of greater satisfaction; and endeavouring to stretch farther, lights upon final causes, which are plainly of the nature of man, rather than of the nature of the universe†. And from this fountain philosophy has been strangely corrupted. For it is as senseless, and unphi-

* See above, *Sect.* I. *Aph.* 14. and hereafter, *Part* II. *Sect.* II.

† For final causes are only expected to be such as satisfy the mind.

losophical, to expect causes in the most general cases, as not to require them in such as are subordinate.

12. The light of the understanding is not a dry or pure light, but drenched in the will and affections, and the intellect forms the sciences accordingly; for what men desire should be true, they are most inclined to believe. The understanding, therefore, rejects things difficult, as being impatient of enquiry, things just and solid, because they limit hope, and the deeper mysteries of nature, through superstition; it rejects the light of experience, through pride and haughtiness, as disdaining the mind should be meanly and waverily employed; it excludes paradoxes, for fear of the vulgar. And thus the affections tinge and infect the understanding, numberless ways, and sometimes imperceptibly.

13. But much the greatest impediment and deviation of the understanding proceeds from the dulness, incompetency, and fallacies of the senses; whence the things that strike the sense, unjustly over-balance those that do not strike it immediately: So that contemplation usually ends with sight, and little or no observation is made of things invisible. And hence all the operations of the spirits, included in tangible bodies, all subtile organizations, and the motions of the parts, are unknown to mankind; and yet,

unless these are discovered and brought to light, nothing very considerable can be done in nature, with regard to works. Nay, the properties of the common air, and numerous bodies of greater subtlety than that, remain almost unknown; for sense, of itself, is a weak and erroneous thing. Nor can instruments, for improving and sharpening the senses, be here of any great service, all true interpretations of nature being made by proper and apposite instances and experiments, wherein sense judges of the experiment only, and the experiment judges of nature, and the fact.

14. The understanding is, by reason of its own nature, carried on to abstraction, and fancies those things to be constant, which are wavering; but it is better to dissect nature, than to abstract her*, as was practised by the school of Democritus, which went farther into nature than any of the rest. And as matter is principally to be considered in all its schemes and organizations, so likewise are pure action, and the laws of action, or motion; but for the Aristotelian forms, they are Idols, or figments of the mind, unless we call the laws of motions, forms†.

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* That is, by making of experiments, rather than by contemplation, and reasoning upon notions, without the proper facts.

† This is meant of abstract forms; but for physical forms, or the essential and efficient cause of the peculiar properties

15. And this kind of Idols are what we term Idols of the Tribe, which have their origin either from 1. the uniformity of the human spirit*; 2. its prepossession†; 3. its narrowness‡; 4. its restless motion‖; 5. the tincture of the affections§; 6. the incompetency of the senses**; or, 7. the manner of the impression††.

16. Idols of the Den take their rise from the peculiar nature of every particular person, both with regard to soul and body, as also from education, custom, and accidents. This kind is various and manifold; but we will touch upon such as require the greatest caution, and have the greatest force to pollute the understanding.

17. Men are fond of particular sciences and studies, either because they believe themselves the authors and inventors thereof, or because they have bestowed much pains upon them, and principally applied themselves thereto. And such men as these, if they afterwards take to philosophy and universal contemplations, generally wrest and corrupt them with their former conceits, of which we have a signal example in Ari-

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of things, it is the principal design of the Second Part of the present Work, to shew how they may be discovered. See *Aph.* 17. of that Part.

* See above, *Aph.* 45. † See *Aph.* 46.
‡ See *Aph.* 47. ‖ See *Aph.* 48. § See *Aph.* 49.
** See *Aph.* 50. †† See *Aph.* 51.

stotle, who made his natural philosophy such an absolute slave to his logic, as rendered it contentious, and in a manner useless. The tribe of chemists, from a few experiments of the furnace, have run up a phantastical philosophy, of very small extent. And so Dr. Gilbert, after he had, with immense labour, prosecuted his magnetical studies, presently invented a philosophy agreeable to his own notion*.

18. The great and radical difference of capacities, as to philosophy and the sciences, lies here, that some are stronger and fitter to observe the differences of things, and others to observe their correspondencies. For a steady and sharp genius can fix its contemplations, and dwell and fasten upon all the subtilty of differences; whilst a sublime and ready genius perceives, and compares, the smallest and most general agreements of things. But both kinds easily fall into excess, by grasping either at the dividing scale, or shadows of things.

19. Some men of genius are wrapped up in the admiration of antiquity, others spend them-

* Thus we see of later date, when Mathematicians apply to physics, medicine, chemistry, &c. they render them all mathematical; when Chemists apply to physics, medicine, &c. they render them chemical; so when Divines apply to philosophy, they often render it scriptural, &c. See below, *Aph.* 65.

selves in a fondness for novelty, and few are so tempered as to hold a mean, but either quarrel with what was justly laid down by the ancients, or despise what is justly advanced by the moderns. And this is highly prejudicial to philosophy and the sciences, as being rather an affectation of antiquity, or novelty, than any true judgment; for truth is not to be derived from any felicity of times, which is an uncertain thing, but from the light of nature and experience, which is eternal. These affectations, therefore, are to be laid aside, and care taken that the understanding be not hurried by them into consent*.

20. To contemplate nature and bodies, in their simplicity, breaks and grinds the understanding; and, to consider them in their compositions and configurations, blunts and relaxes it, as appears plainly upon comparing the school of Leucippus and Democritus with the other philosophies. For the former is so taken up with the particles of things, as almost to neglect their structure, whilst the other views the fabrication of things with such astonishment, as not to enter into the simplicity of nature. Both these contemplations, therefore, are to be taken

* How much regard has been had to this Aphorism, in the late contests for and against the superiority of ancient and modern learning!

up by turns, that the understanding may at once be rendered more piercing and capacious, and the inconveniencies above-mentioned, with the Idols thence arising, be prevented.

21. And, in this manner, let contemplative prudence proceed, in chasing and dislodging the Idols of the Den, which principally have their rise, 1. from prevalency; 2. the excess of composition, and division; 3. affections for times; or, 4. from too great and too small a size of objects*. And, in general, whoever studies the nature of things, should hold for suspect whatever powerfully strikes and detains the mind, and use so much the greater caution to preserve his understanding pure and equable, in such kind of tenets.

22. But none are so troublesome as the Idols of the Market, which insinuate themselves into the mind, from the association of words and terms. For though men believe that their reason governs words, it also happens that words retort, and reflect their force upon the understanding; whence philosophy and the sciences have been rendered sophistical, and unactive. Words are generally imposed according to vulgar conceptions, and divide things by lines† that are most apparent to the understanding of

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* See *Aph.* 54, 55, 56, 57. † Differences, or distinctions.

the multitude: And when a more acute understanding, or a more careful observation, would remove these lines, to place them according to nature, words cry out, and forbid it. And hence it happens, that great and serious disputes of learned men frequently terminate in controversies about words and terms, which it were better to begin with, according to the prudent method of the Mathematicians, and reduce them to order by definitions. But in natural and material things, even these definitions cannot remedy the evil; because definitions themselves consist of words, and words generate words, so that, of necessity, recourse must be had to particular instances, their series, and orders, as we shall shew, when we come to the manner of raising notions and Axioms.

23. The Idols which words impose upon the understanding are of two kinds, as being either the names of things that have no existence, or the names of things that do exist; but names confused, ill defined, and rashly and irregularly abstracted from things. Of the former kind are such as fortune, the *primum mobile*, the orbs of the planets, the element of fire, and the like figments, which arise from imaginary and false theories. For as there are things that, through want of being observed, remain without names, so there are names coined upon phantastical con-

ceits, and have no things corresponding to them. Idols of this kind are dislodged by a constant rejection and repeal of theories, and phantastical notions*.

24. But the other kind, raised by a wrong and unskilful abstraction, is intricate and deep rooted. For example; let us choose any word, as the word moisture, for instance, to try how far the things agree which are signified by it, and we shall find it no other than a confused mark of different actions, that are inconstant and irreducible to one another. For moisture signifies, 1. that which can easily diffuse itself round another body; 2. that which is indeterminable of itself, and cannot fix; 3. that which yields easily every way; 4. that which readily divides and scatters itself; 5. that which easily unites with itself, and collects together; 6. that which easily flows, and is easily put in motion; 7. that which readily sticks to another body, and wets it; 8. that which is easily melted, or reduced from a solid to a liquid. And, therefore, when this term comes to be published and imposed, with an exception of some of the significations, flame will be moist; with the exception of others, air is not moist; and, again, with some other exceptions, fine powders and glass are

* See Mr. Locke's Essay upon Human Understanding, Chap. of Words. See also hereafter, *Aph.* 64, &c.

moist. Whence it easily appears that this notion is inconsiderately taken from water only, and some other common and obvious liquors, and not duly verified *.

25. There are also certain degrees of error and depravity in words. The least faulty kind is that of the names of substances, especially the lower species, which are well deduced; for the notions of chalk and clay are just, but the notion of earth inadequate. The tribe of actions is more faulty, such as generation, corruption, and alteration but the notions of qualities, except the immediate objects of sense, are the most depraved, as gravity, levity, tenuity, density, &c. Yet some of these notions must, of necessity, be juster than others, in all the kinds, according to the number of instances that have fallen under the senses †.

26. But for the Idols of the Theatre, they are neither innate, nor secretly insinuated into the understanding, but plainly palmed upon it, and received from fabulous theories, and the perverted laws of demonstration. To undertake a confutation of these, is by no means congruous with

* A language formed and verified after the manner here indicated, is greatly wanting in philosophy; and perhaps cannot be compleated, till philosophy itself is perfected.

† Whence it is plain, that a just language cannot be formed without a competent knowledge of philosophy.

what we have already advanced*, for where neither principles nor demonstrations are agreed upon, there can be no arguing. And this happens fortunately, to leave the ancients possessed of their glory; we can detract nothing from them, whilst the question is only concerning the way†. And a cripple in the right way may beat a racer in the wrong one. Nay, the fleeter and better the racer is, who has once missed his way, the farther he leaves it behind. Our method, however, of discovering the sciences, does not much depend upon subtilty, and strength of genius, but lies level to almost every capacity and understanding. For, as it requires great steadiness and exercise of the hand to draw a true strait line, or a circle, by the hand alone, but little or no practice with the assistance of a ruler or compasses; so it is with our method. And although there be here no use of particular confutations, yet some notice must be taken, 1. of the sects and sorts of these theories; 2. the false colours thereof; 3. the causes of so great an infelicity; and, 4. the causes of so lasting and

* See above, *Aph.* 35.

† The Author is extremely apprehensive of being suspected to rival the ancients; which apprehension, if he had not well guarded against it, might have prejudiced his whole design, as indeed it in some measure did, and still continues to do, with many.

general a consent in error; and all this, that the passage to truth may be made the easier, and the understanding the more disposed to cleanse itself, and put away its Idols*.

SECTION III.

OF THE DIFFERENT PHILOSOPHICAL THEORIES.

1. THE Idols of the Theatre, or Theories, are many, and will probably grow much more numerous†; for if men had not, through many ages, been prepossessed with religion and theology, and if civil governments, but particularly monarchies, had not been averse to innovations of this kind, though but intended, so as to make it dangerous and prejudicial to the private fortunes of such as take the bent of innovating, not only by depriving them of advantages, but

* Dr. Hooke has familiarized and illustrated some part of this doctrine of Idols, in his General Scheme, or Idea of the present State of Natural Philosophy. See Hooke's Posthumous Works, p. 7—11.

† The number of them has been great, ever since this Piece was wrote.

also by exposing them to contempt and hatred, there would, doubtless, have been numerous other sects of philosophies and theories introduced, of kin to those that, in great variety, formerly flourished among the Greeks. And these theatrical fables have this in common with dramatic pieces, that the fictitious narrative is neater, more elegant and pleasing, than the true history *.

2. In general, philosophy receives much matter from a few particulars, or else but little from many; so that, in both cases, it is founded on too narrow a basis of experience and natural history, and pronounces from too little knowledge †.

3. (1.) The rational tribe of philosophers hastily take up vulgar things from experience, without finding them to be certain, or carefully examining and weighing them; and commit all the rest of the work to thought, and the discussion of the wit ‡.

4. (2.) Another kind of philosophers labour, with great diligence and accuracy, in a few experiments, and thence venture to deduce and build

* Thus the Cartesian philosophy is more agreeable to read than the Newtonian.

† Commonly in the way of the vulgar Induction abovementioned, *Aph.* 17.

‡ See more of this below, *Aph.* 63.

up philosophies; and strangely wrest every thing else to these experiments*.

5. (3.) Lastly, there is a kind of such as mix theology, and traditions of faith and worship, with their philosophy; and the vanity of some among them has turned aside, to derive the sciences from spirits and angels†; so that the origin of errors, and false philosophy, is of three kinds; *viz.* 1. sophistical; 2. empirical; and, 3. superstitious‡.

6. We have an eminent example of the first kind in Aristotle, who corrupted natural philosophy with his logic, in forming the world of categories or predicaments, passing over the business of rarifaction and condensation, with the *jejune* distinction of act and power, asserting but one proper motion to all bodies, and imposing numerous other fictions, at his own pleasure, upon the nature of things, being all along more solicitous how men might defend themselves by answers, and advance something that should be positive in words, than to come at the inward truth of nature‖. This will appear to the full,

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* See below, *Aph.* 64.

† Thus, in particular, chemistry and natural magic, have been thought derived from angels and spirits.

‡ See below, *Aph.* 65.

‖ As our education in Europe is chiefly Aristotelian, we should have a strict watch upon ourselves in all philosophi-

by comparing the philosophy of Aristotle with the other philosophies, that were celebrated among the Greeks. For the Homoiomera of Anaxagoras, the Atoms of Leucippus and Democritus, the Heaven and Earth of Parmenides, the Enmity and Amity of Empedocles, the Resolution of Bodies into the neutral Nature of Fire, with their return to density, according to Heraclitus, all savour somewhat of natural philosophy and experience; whereas both the physics, and metaphysics, of Aristotle, speak little more than logical terms. It is true, his Books of Animals, Problems, and other pieces, make frequent use of experiments; but then he had first pronounced without their assistance, and did not duly consult experience in forming his decrees and Axioms; but after he had passed judgment, according to his own humour, he winds experience round, and leads her captive to his opinions. And, upon this account, he is more culpable than his modern followers, the scholastic philosophers, who meddled not with experience at all.

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cal enquiries, writings, and discourses, that we are not led away with Aristotelian notions. It should seem as if all our common reasoning was infected with Aristotelian prejudices, so as to be affectedly logical and captious, rather than just and philosophical, or formed upon the true nature of things. See hereafter, *Aph.* 77.

64. But the empirical philosophy produces opinions more deformed and monstrous than either the sophistical or the rational, as not being founded in the light of vulgar notions, (which, though slender and superficial, is yet in some sort universal) but rests in the narrow confines and obscurity of a few experiments. Whence such a philosophy appears probable, and in a manner certain, to the men who daily converse with these experiments, and thereby deprave their imagination *, whilst to all others it seems incredible and vain. We have a notable examample hereof in the chemists, and their doctrines, though the like, at this time, perhaps, is not to be found, unless in Gilbert's philosophy. Yet the caution, with regard to these philosophies, should by no means be passed over, because we foresee, and venture to foretel, that if mankind, being admonished by us, shall at length, in ear-

* That is, give it a bent some one particular way, as we see in those who have long applied themselves to a certain trade, the discovery of the longitude, the making of gold, the writing a certain book, or the prosecuting any one set of experiments; for thus, without a prudent change and intermixture of studies and employments, the mind will be warped, and strangely draw foreign things to some consent with those under consideration, or else neglect and overlook whatever does not immediately regard the present view.

nest, betake themselves to experience, and lay aside sophistical doctrines; even then, through an over eager and precipitant hurry of the understanding, and the desire it has of bounding or flying to generals, and first principles, there will be great danger from these narrow philosophies *, which is an evil we ought to remedy †.

65. But the corruption of philosophy, from the admixture of superstition and theology, is much more extensive and pernicious, either to whole bodies of philosophy, or their parts; for the understanding is as subject to the impressions of fancy, as to the impressions of vulgar notions. The disputations, or sophistical philosophies, may indeed entrap the understanding, but the superstitious, tumid, and, as it were, poetical kind, flatters and courts it more; for men have a certain pride of the understanding, as well as of the will, especially men of an elevated genius ‡.

We meet with an example of this kind among the Greeks, and principally in Pythago-

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* Thus, though there is always some one reigning or general philosophy, yet almost every enquirer into nature has a particular lesser system formed upon his own experience. This appears remarkably in the Members of the Royal Academy of Sciences at Paris, &c.

† Regard is had thereto through the whole course of the Work.

‡ See below, *Aph.* 71.

ras, though joined with a gross and burthensome superstition*; but a more dangerous and subtile one in Plato, and his school†. The same kind of mischief likewise happens in the parts of the other philosophies; as, by introducing abstract forms, final causes, and first causes, commonly omitting those that are intermediate. And in this case the utmost caution should be used, for nothing is more pernicious than to canonize errors; and to venerate vanities, should be accounted the pest of the understanding. Yet some of the moderns have so far indulged this strange levity, as to endeavour the founding of natural philosophy upon the first chapter of Genesis‡, the book of Job, and other parts of sacred writ, thus seeking the dead among the living. And this vanity is so much the rather to be restrained and suppressed, as from the wild mixture of divine things with human, arise not only phantastical philosophies, but heretical religions‖. It is, therefore, of great importance, with a sober mind, to give to faith no more than the things that are faith's. And thus much for

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* See hereafter, *Aph.* 105.

† See below, *Aph.* 75, 76, 77, 96, 105.

‡ See Dr. Keil's Philosophical Examination of certain Theories of the Earth.

‖ This caution appears to have been too little observed by the modern philosophers.

the bad authorities of philosophies, which are founded, 1. in vulgar notions; 2. scantiness of experiments; and, 3. in superstition*.

66. We proceed next to the corrupt matter of contemplation†, especially in natural philosophy. The understanding is perverted by the sight of things performed in the mechanic arts, which generally alter the bodies by composition or separation‡; whence men are apt to imagine that something of the like kind happens in all natural bodies; and from this notion, the figment of the elements, and their uniting to compose all natural bodies, had its rise. Again, when men contemplate nature in her freedom, they meet with different species, or appearances, of things, as animals, vegetables, minerals, and hence readily imagine there are in nature certain primary forms, or differences, which she endeavours to disclose or educe; whilst the other varieties proceed from some impediments and deviations of nature in her work, or from the struggle of different species, or bodies, together, and

* As is shewn in the preceding Aphorisms, 63, 64, 65.

† *Viz.* Where erroneous notions are formed of things; and applied, by the mental powers, in the building up of philosophy.

‡ And hence mechanics and chemists are frequently deceived, when they suppose that nature separates and joins bodies, after the manner that men join and separate them.

the transplantation of one into another*. The former imagination produced the notion of primary, or elementary qualities, and the latter that of occult qualities, or specific virtues; both which are owing to the empty abridging of contemplations, wherein the mind resting, is kept from more solid knowledge. But physicians operate better by means of the secondary qualities, and virtues of things, such as those of attracting, repelling, attenuating, discussing, ripening, &c. and might have advanced much farther, but for that fruitless abridgment by the above-mentioned elementary qualities, and specific virtues, wherewith they corrupt the others, which are justly observed, either by reducing them to primary qualities, and their subtile and incommensurable mixtures, or by not carrying them on, with continued diligence and observation, to third and fourth qualities, but unseasonably breaking off the consideration. Nor are these, and the like qualities, to be enquired after only in medicines for the human body, but also in the changes of all other natural bodies†.

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* As when monsters are produced.

† If light be required in this subject, Mr. Boyle's Enquiry into the Origin of Forms and Qualities, may be advantageously consulted. See, in particular, the Abridgment of his works, Vol. I. p. 271, 272.

But it is much more prejudicial, that the *quiescent* principles, whereof things consist, should be studied and enquired into, and not the moving principles whereby they act; the former relating to dscourse, but the latter to works. For those vulgar differences of motion in the common natural philosophy, such as generation, corruption, augmentation, diminution, alteration, removal, &c. are of little significancy, as meaning no more than that if a body, otherwise unmoved, be put out of its place, this is removal; but if the place and appearance remain the same, and the body be changed in quality, this is alteration; and if, from such a change, the bulk and quantity of the body do not remain the same, this is a motion of augmentation, or diminution; but if bodies are so far altered as to change both appearance and substance, and turn into others, this is generation and corruption. But these are mere popular notions, that no way enter into nature, being only the measures and periods, and not the species of motion*; and pointing out only how far, and not by what means things have proceeded. Nor do they intimate the appetites of bodies†,

* For the species of motion, see hereafter, *Part* II. *Aph.* 48.

† *Viz.* The dispositions that bodies have to be affected and altered by each other, upon contact, mixture, &c. as the loadstone attracts iron, gold attracts quicksilver, &c.

or the operations of their parts, but only when the motion exhibits a thing to the sense, in a gross manner, different from what it was; men there begin their distinction. Nay, when they would intimate any thing, as to the causes of motions, and raise a division from them, they idly introduce a jejune distinction betwixt natural and violent motion, this itself being but a mere vulgar conceit; for all violent motion is truly natural, the external efficient only setting nature otherwise at work than she was before*.

On the other hand, if any one should observe that bodies have an appetite to touch each other, so as to prevent a vacuity or separation in the union of nature, or that bodies have an appetite of contracting themselves within their own natural dimensions, out of which, when they are either stretched or squeezed, they immediately endeavour to restore themselves, and recover their former state, or that bodies have an appetite of coming together to the masses of matter similar to them; that is, the mass of dense bodies towards the globe of the earth: These, and all such, are true physical kinds of motion. But the former are merely logical and scholastic, as will manifestly appear, by comparing the two together.

* This is farther illustrated in the Second Part of the present Work.

Nor is it a less misfortune, that men, in their philosophies and contemplations, bestow their time in discovering and treating the ultimate principles, or last resorts of nature; whereas all utility, and power of acting, lies in the midway*. But, generally, men cease not to abstract nature, till they arrive at potential and uninformed matter, or till they have divided her so far that they come to atoms, which things, though ever so real, make but little to the advantage of mankind†.

67. The understanding also is to be guarded against the excesses of philosophies, as to the yielding or withholding of assent; because such kind of excesses seem to fix, and in a manner perpetuate idols, as not allowing any opportunity for their removal.

These excesses are of two kinds: the one belonging to such as pronounce hastily, and make the sciences positive and magisterial; the other to those who have introduced scepticism, and a vague indeterminate method of enquiry. The former of these depresses, and the latter enervates the understanding. The philosophy of Aristotle, (when, after the Turkish manner, it had slain its brother rivals to the throne) pro-

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* This is already explained under *Aph.* 48, 51, 57.

† See above, *Aph.* 19, 20, 21, 22.

nounced upon every thing, suborning questions at pleasure, and dispatching them again, to shew that all was now certain and decided. And this method has also prevailed, and is in use, among the Aristotelian successors of philosophy *.

But the school of Plato introduced scepticism, at first in the way of jest and irony, to oppose the ancient sophists, Protagoras, Hippias †, and the rest, who feared nothing so much as the appearing to doubt of any thing. But the new academy dogmatized upon scepticism, and professed it. And though this was a fairer procedure than by pronouncing licentiously, (for they declared they meant not to confound enquiry, as Pyrrho and his followers did, but held what they pursued as probable, though not what they professed as true) yet, when once the mind despairs of finding truth, all things languish; whence men rather turn aside to philology, agreeable conversation, discourse, and roving, than confine themselves to the severity of enquiry. But the point we constantly have before us, is not to lessen the authority of the sense and intellect, and expose their imperfections, but to afford them all the helps we can.

68. And thus much for the several sorts of Idols, which are all of them to be solemnly and

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* See hereafter, *Aph.* 71, 72. † See below, *Aph.* 71.

for ever renounced, that the understanding may be thoroughly purged and cleared; for the kingdom of man, which is founded in the sciences, can scarce be entered otherwise than the kingdom of God; that is, in the condition of little children*.

69. Corrupt demonstrations serve as the guards and defenders of the Idols of the mind, logical demonstrations being generally such as subject and enslave the world to the thoughts of men, and thoughts to words†: whereas genuine demonstrations are, potentially, sciences and philosophies themselves‡. For such as are the demonstrations, or according as they were conducted well or ill, such are the doctrines and speculations that follow upon them. These demonstrations we at present use in the whole process that leads from sense and things, to Axioms

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* *Viz.* By discharging all the false, complex ideas, and unjust notions, enforced or embibed through education, custom, prejudice, particular studies, or any of the causes above-mentioned.

† It must here be remembered, what was said above, that Syllogisms consist of propositions, propositions of words, &c. See *Aph.* 11, 12, 13. and again, 24, 47.

‡ See *Aph.* 22. Demonstrations are potentially sciences and philosophies; because, as the demonstrations are just or false, so will the doctrines that follow from them be true or erroneous.

and conclusions, are fallacious and insufficient*. This process is of four kinds, and so are its errors. 1. The impressions of the sense itself are vicious, for the sense both fails and deceives; but its failures are remedied by substitution, and its fallacies by rectification†. 2. Notions are ill formed from the impressions of the senses, and prove indeterminate and confused, but ought to be clear and well limited‡. 3. Induction is faulty, as inferring the principles of the sciences by simple enumeration, without duly excluding, resolving, and separating things or natures§. 4. Lastly, that method of invention and proof which first raises the most general principles, then applies the intermediate Axioms thereto, and tries them, is the mother of errors, and the destruction of all the sciences‖.

70. But experience is by far the best demonstration, provided it dwell in the experiment, for the transferring of it to other things judged alike, is very fallacious, unless done with great exact-

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* See above, *Aph.* 26, 27, 28, 29.

† *Viz.* By means of suitable instruments and experiments. See *Aph.* 10, 18, 50. But for assisting, rectifying, and verifying the senses, see hereafter, *Part* II. *Aph.* 38, 39, 40, &c.

‡ See *Aph.* 15, 18, 19, 20, and 40.

§ See *Aph.* 14, 18, 19, 20, 21, 22.

‖ See above, *Aph.* 19, &c.

ness and regularity. But the present method of experimenting is blind and stupid*; and therefore, whilst men wander, and hold no certain course, but take advice only as things occur; they are hurried round to abundance of particulars, without advancing forward. And sometimes they are pleased, sometimes disconcerted; but always find matter of farther enquiry†. It comonly happens, that men make experiments slightly, and as in the way of diversion, somewhat varying those already known; and if they succeed not to their expectation, they grow sick of the attempt, and forsake it. Or, if they apply in earnest to experiments, they commonly bestow all their labour upon some one thing, as Gilbert upon the loadstone, and the alchemists upon gold. But this procedure is as unskilful as it is fruitless: For no man can advantageously discover the nature of any thing in that thing itself; but the enquiry must be extended to matters that are more common‡.

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* Not led by any light of knowledge, or Axioms; but proceeding by conjecture, and at random.

† The remedy for all this is proposed in the Second Part of the Work.

‡ Thus, in the enquiry after the means of prolonging life in man, the Author first enquires into the ways of rendering simpler bodies durable, and endeavours to find out the requisites for that purpose; then transfers so much as is suitable of the discovery, to the human body.

Again, if men do prosecute any science or doctrine, in the way of experiment, yet they generally go off to practice hastily and unprepared; and this not so much for the use and benefit of the practice itself, as to receive a kind of security in some new work, that they shall not fruitlessly employ themselves in others; as also, that, from a manifestation of their success, they may procure a better opinion of themselves, as to what they have in hand. And thus, like Atalanta, stooping to take up the golden fruit, they interrupt the course, and lose the victory. But, in the true course of experience, and applying it to new works, we should follow the example of the divine wisdom and order. For as God, in the first day of creation, made nothing but light, allowing one whole day to that work, without creating any material thing therein, so causes and true Axioms are first to be drawn out from all kinds of experience, and the experiments of light, and not of profit, to be investigated. For Axioms, duly discovered and established, will afford plentiful harvest of practice, and draw after them whole sheaves of works*.

* It is extremely difficult to convince the mind of this; at least, so far as to make men act upon it. For philosophers do not seem greatly employed in discovering these causes, and raising these Axioms, upon which a serviceable philosophy is to be founded.

At present, we have only spoke of vulgar experience, as a false demonstration; but shall hereafter consider those ways of experimenting, which are no less blocked up and beset than the ways of judging. But first, we must treat of the signs that manifest the present philosophy, and the sciences, to be faulty; as also the causes of so strange a thing: For these are two very useful means of gently and calmly extirpating the idols of the mind; as a knowledge of the signs prepares the assent; and the explanation of the causes takes away the miracle.

SECTION IV.

OF THE SIGNS, OR CHARACTERISTICS, OF FALSE PHILOSOPHIES.

71. THE sciences we possess are almost wholly derived from the Greeks: For what the Roman, Arabian, and more modern authors have added, is not much, or of any great weight; and also built upon the discoveries made by the Greeks. But the knowledge of the Greeks was of the professorial and disputatious kind; which is absolutely unfit for searching after truth. And hence

the name of Sophist was, by those who desired to pass for philosophers, contemptuously thrown upon the old rhetoricians; as Gorgius, Protagoras, Hippias, Polus, and almost the whole number; as Plato, Aristotle, Zeno, Epicurus, Theophrastus, and their successors Crysippus, Carneades, &c. There was only this difference betwixt them, that the former were a wandering, mercenary tribe, who went from city to city, making a shew of their wisdom, and asking a reward; whilst the other were more grave and generous; who having fixed habitations, opened their schools, and taught without fee. Yet both kinds were professorial; they both reduced every thing to dispute; and instituted and defended certain sects and heresies of philosophy: so that their doctrines, as Dionysius sharply said of Plato, were only the talk of idle old men, to raw young fellows. But the more ancient among the Greeks, as Empedocles, Anaxagoras, Leucippus, Democritus, Parmenides, Heraclitus, Xenophanes, Philolaus, &c. opened no schools that we hear of; (for we omit Pythagoras, as superstitious *;) but applied themselves to the discovery of truth with greater severity and simpli-

* In another place, the author observes of Pythagoras, that his doctrine and discoveries principally regarded the founding of a certain religious order, rather than the opening any school of philosophy: as may appear from the event:

city; or with less affectation and show. And hence, we conceive, they made a greater progress *; only through tract of time their works are lost, and superseded by lighter studies; which prove more pleasing, and better suited to the vulgar capacity and affections: time thus, like a river, bringing down to us such things as are light and tumid; but sinking those that are weighty and solid. Neither were these philosophers clear of the fault of their nation; but had too strong an ambition and vanity for building

because his doctrine prevailed more in the Manichean heresy, and the Mahometan superstition, than among philosophers.

* The Author, in another place, observes, that we have the works of Plato and Aristotle extant; so that we may form some tolerable judgment of their philosophies, from the fountains themselves: But as to Pythagoras, Empedocles, Heraclitus, Anaxagoras, Democritus, Parmenides, Xenophanes, &c. the case is different; because we have only some fragments preserved of them, and receive their opinions at second hand, or from certain rumours: so that to discover their philosophies, requires greater diligence of enquiry, and soundness of judgment, to balance the loss. Upon this the Author declares, he had, with the utmost diligence and exactness, collected all that related to their opinions, from Aristotle's confutations thereof, or as they are cited by Plato and Cicero; the collections of Plutarch, the Lives of Laertius, the poem of Lucretius, or wherever else he could find the least mention of them; and faithfully examined the whole.

sects, and acquiring popular fame. But the search after truth is to be held desperate, when it turns aside to such empty things as these. The Egyptian priest judged, or rather prophesied, well of the Greeks; that they would always be children; without antiquity of knowledge, or knowledge of antiquity: and indeed, they have this property of children, that they are ready at talk, but unripe for generation; their knowledge being verbal, and barren of works. And therefore, the characteristicks of the philosophy in use among us, taken from that origin and nation, are false and deceitful*.

* The philosophies of Plato and Aristotle are the chief of those delivered down, in any tolerable perfection, to us from the Greeks. That of Aristotle has been diligently explained, and illustrated; but less pains seems taken with the Platonic philosophy. The Author observes, that Aristotle's philosophy is founded in vulgar notions; and the useless comparing of them together; so as to shew where they clash, and how they may be reconciled; whilst nothing solid can be expected from the man, who made the system of the world a logical thing; and corrupted all his natural philosophy with logical terms and notions. As for Plato, the Author esteems him a man of a more sublime genius; who attempted even the discovery of forms; and used the form of Induction, not only in principles, but in every thing; though after a fruitless manner; as always catching at, and receiving, vulgar Inductions, and abstract Forms: so that whoever attentively considers his writings and manner, will find he was not very solicitous about natural philo-

72. Nor are the signs taken from the time and age of the Grecian philosophy, much better than those taken from the nature of the people For that age had but a very slender knowledge, both of times, and the habitable world: which is a great defect, especially with such as place all things in experience. For they had not the history of a thousand years, that deserved the name of a history; but only fables, and rumors of antiquity. And for the different countries of the world, they knew but a very small part thereof; as calling all the more northern people Scythians; and all the western Celtæ, indiscriminately. They had no knowledge in Africa, beyond the nearest part of Ethiopia; nor in Asia, beyond the Ganges: and for the new world, they never heard of it; nor had any certain tradition about it. Nay, they pronounced many climates and zones uninhabitable; where infinite people are found. And for the travels of Democritus, Plato, Pythagoras, &c. though celebrated as something considerable, they were but short; and almost within their own walls, com-

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sophy; only so far as might serve to keep up the name and reputation of a philosopher; and enable him to grace, or add a certain majesty, or dignity, to his civil and moral doctrines; whilst, at the same time, he corrupted nature as much by his theology, as Aristotle did by his logic; and approached as near to a poet, as Aristotle did to a sophist.

pared with the voyages of our times, into numerous parts of the new world, and the extremities of the old: whence we are supplied with a vast stock of experiments. And therefore, if signs are to be taken of philosophies, in the astrological manner, from the times of their generation and nativity; no great good is thence promised of the ancient.

73. But of all the signs of philosophies, none are more certain and noble, than those taken from their fruits: for fruits, and the discoveries of works, are as the vouchers and securities for the truth of philosophies. But from the philosophies of the Greeks, and their descents through particular sciences, now for the space of so many years, scarce a single experiment can be produced, tending to accommodate or improve the state of man, that may be justly attributed to the speculations and doctrines of their philosophy. And thus much is ingenuously and prudently allowed by Celsus, that experiments in medicine were first made, and that men afterwards philosophized upon them, to find out and assign their causes; but did not, contrariwise, discover and deduce experiments from philosophy, and the knowledge of causes. Whence it was no wonder the Egyptians, who bestowed divinity and consecration upon the inventors of things, had more images of brutes, than of men:

for brutes, by their natural instinct, have made many discoveries; whilst men, with their discourses and rational conclusion, have made few or none.

'Tis true, the industry, of the Chemists has produced some; though rather accidentally, and without design; or by varying experiments, as mechanics do; and not by the rules of art, or from theory: for the theory which they have imagined is rather hurtful than advantageous. So likewise the natural magicians have discovered a few light things, that approach to imposture; and therefore, as 'tis a caution in religion, that faith be manifested by works; an admirable rule may be hence derived into philosophy, viz. that it be judged by its fruit; and held as vain, if it prove barren: and this the more, if instead of grapes and olives, it produces the thistles and thorns of disputes and altercations.

74. Signs are also to be taken from the progress and increase of philosophies, and the sciences: for things planted in nature will grow, and enlarge; but things founded in opinion will differ, and not thrive. And therefore, if the ancient doctrines had not been like plants plucked up and severed from their roots, but still adhered to the womb of nature, and were fed by her; that could not have happened, which we see has happened, for these two thousand years: the

sciences still remaining where they were; and almost in the same condition, without any considerable improvement: nay, they rather flourished most in their original authors, and afterwards declined. On the contrary, the mechanic arts, which are founded in nature, and the light of experience, and remaining pregnant, as it were, with spirit, so long as they continue to please; are ever upon their increase and growth; being first rude, then fashioned, and, lastly polished, and perpetually improved.

75. There is another sign to be taken from the confession of the authors themselves, now followed by mankind: though this is rather a testimony, of the strongest kind, than strictly a sign. For though these Authors pronounce upon things with so much confidence; yet at intervals, when they come to themselves again, they fall upon complaining of the subtilty of nature, the obscurity of things, and the insufficiency of the human nature. And if this were done in simplicity, it might deter the fearful from farther enquiry; and stir up others of a brisker and more daring genius, to a farther prosecution: But not content to acknowledge only for themselves; they place beyond the bounds of possibility, every thing that was either unknown, or untried by them or their masters; and thus haughtily and invidiously pronounce things im-

possible to art; and bend the weakness of their own discoveries, to calumniate nature, and propagate despair. Hence proceeded the new school of the Academics, which made profession of scepticism, and condemned mankind to eternal darkness *: hence the opinion, that physical forms, or the real differences of things, were impossible, or beyond the power of man to discover: hence those notions as to operations, that the heat of the sun is a thing absolutely different from the heat of fire; lest men should think they might produce by fire, some things like the productions of nature. And hence proceeds the notion, that composition only was the work of man, and mixture the work of nature; to keep men from expecting any artificial Generation, of transformation of natural bodies †! And thus men are easily persuaded, by this false colour, not to risk their fortunes, and their labours, in things not only condemned, but already given up to despair ‡.

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* See above, *Aph.* 67.

† The Author has a great regard to the abolishing of these false imaginations. See the second part of the present work.

‡ This seems to be a grand obstruction to the improvement of philosophy and arts; and extremely difficult to remove; as having not only mens natural indolence to struggle with; but also their artificial and learned despondency;

76. We must not omit that other sign; viz. the great disagreement among the ancient philosophers, and the differences of their schools; which sufficiently shews, that their way from sense to the understanding was not well guarded; whilst one and the same subject of philosophy, the nature of things, was rent and split into so many, and such wild errors. And although, at present, the dissentions and disagreements of opinions, as to first principles, and entire philosophies, are in a manner extinct *; yet such innumerable questions and controversies still remain among us, as make it plainly appear, that there is nothing fixed and stable, either in our present philosophies, or the manner of our demonstrations†.

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in which sober and intelligent persons generally think they shew their judgment. And hence new improvements in mechanics, medicine, &c. meet with a slow reception, by those esteemed for sobriety and judgment. And though this slowness may often be well placed; yet, in general, it appears to proceed from a want of knowing the powers of man and nature: or from an inveterate prejudice against the possibility of doing things not done, or not believed to have been done before. The following fifth and sixth sections are directly levelled at reforming this error.

* As chiefly agreeing in the Peripatetic doctrine.

† The uncertainty of the common demonstrations might give occasion to the introducing of mathematical ones into physics; and these being the most certain, if they could be universally applied, men would then differ in philosophy as

77. Men have an opinion of a general consent in the philosophy of Aristotle; as if, after that was once published, the more ancient philosophies ceased, and grew into disuse; and that nothing better was discovered in the succeeding ages; this being so well founded, as to draw both former and latter times into it: But the whole is a fallacy. For (1.) the works of the more ancient philosophers were in being to the times of Cicero, and the following ages; till the inundation of the barbarians upon the Roman empire; when the philosophies of Aristotle and Plato were saved from the general shipwreck of human learning; as light planks, supported by the waves of time. And (2.) that alone can be justly called consent, which consists in a freedom of judgment agreeing in the same thing, after due examination: but far the greater number of those who consent in Aristotle's Philosophy, are enslaved to it by the prejudice and authority of others; so that it is rather an obsequiousness than a consent. But though it were a free and general consent; yet consent ought to be so far from passing for any real authority,

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little as they do now in mathematics: but it may deserve a serious consideration, whether mathematical demonstrations, applied to matter, are suited to the purpose; or do not, like the common syllogism, let nature slip through; and leave the demonstration an empty thing.

as to give a violent suspicion of the contrary: for of all characteristicks, that is the worst which men take from consent, in matters of the understanding; except such as concern religion and politics, which properly go by voices. For nothing can please the many, but what strikes the imagination; or binds the understanding with the cords of vulgar notions*. So that the thought of Phocion†, may be justly transferred from morals to intellectuals; for men ought directly to examine themselves, wherein they have erred, or done amiss; when the multitude consents, and applauds them. This sign, therefore, of general consent, is one of the most unfavourable that a philosophy can have‡. And thus much for the false characteristicks of the philosophies and the sciences, in use; whether taken (1.) from their origins; (2.) their fruits; (3.)

* This aphorism requires a strict attention; and unless the mind be thoroughly convinced of the truth and certainty thereof, the reader will, on many occasions, be apt to conceive, that in what follows, the Author is delivering a kind of laborious, learned dream, instead of a solid useful work.

† Phocion being once highly applauded by the multitude, turned round to his friends, and asked what absurdity he had committed.

‡ Because, if the consent be general, the vulgar also must be admitted judges; and we all know what judges they are, and what the things must be that please the multitude.

their progress; (4.) the confessions of their own authors: or (5.) from consent*.

SECTION V.

OF THE CAUSES OF ERRORS IN PHILOSOPHIES.

78. WE next proceed to the numerous and prevalent causes of errors, and their continuance through so many ages; that men may no longer wonder, how the things we advance have hitherto been hid from them; and this alone remain the surprize, how they should now come into any one's mind: which, however, in our judgment, is owing to a felicity; and not to any excellence of talent; so as rather to appear the product of time, than the product of genius †.

* See *Aph.* 71—77.

† In reading the Author's works, this seems to be the general stumbling-stone: *How should he be able to do more than* Plato, Aristotle, *and all the ancients put together? Shall he only be in the right, and every body else in the wrong? Such a conceit of a man's own ability is monstrous shocking, and intolerable.* This is reasoning by anticipation; or in the common way of men. But when the fury is over; the question to be calmly considered is, *What has he done?* But to conquer prejudice, and bring the mind better prepared to consider of this question, the Author here endeavours to account for the strangeness of the thing; and to pacify and reconcile the mind, before he informs it.

And (1.) so many ages, if justly considered, shrink to a small compass; for of twenty-five centuries, wherein the memory and learning of mankind have been exercised, scarce six can be culled out as fertile in sciences, or suitable to their improvement: for times, as well as countries, have their wastes and desarts. There can be properly reckoned but three periods and revolutions of learning; one among the Greeks, another among the Romans, and the third among ourselves, or the western nations of Europe; to each whereof scarce two centuries can be fairly attributed. The middle ages of the world were unhappy, as to any plentiful harvest of the sciences. Nor need we mention any thing either of the Arabians, or the school-men; who, in the intermediate times, rather ground down the sciences by numerous treatises, than added to their weight*. And therefore, the first cause of so little progress in knowledge, is, properly, a scantiness of times well suited for it.

79. (2.) A second cause, of very great moment, is, that through all those ages, wherein men of genius and learning principally, or even moderately, flourished; the smallest part of human industry has been spent upon natural philo-

* As repeating the same matter over and over again; and new modelling and dividing it, without making any considerable addition thereto.

sophy; though this ought to be esteemed as the great mother of the sciences *: for all the rest, if torn from this root, may perhaps be polished, and formed for use; but can receive little increase, And, 'tis manifest, after the Christian religion was received, and gained ground, that much the greater part of the fine geniuses bent themselves to theology; whereto both the noblest rewards were annexed, and all kinds of assistance liberally afforded. And this study chiefly employed the third period of time † amongst the Western Europeans; the more, as learning then began to flourish, and controversies about religion to arise. But, in the preceding age, during the second period, the principal study and labour of the philosophers, among the Romans, were bestowed upon morality; which, to the heathens, was instead of theology. Besides, the greatest geniuses of those times chiefly applied themselves to politics; the large extent of the Roman empire requiring large assistance. But that time wherein Natural philosophy seemed

* Natural philosophy, that is, a knowledge of nature, appears to be the great mother of the sciences; because neither the arts of speech, logic, medicine, civil policy, morality, religion, &c. can be advantageously exercised, improved, understood, or instituted without it: and all the mechanical arts depend upon it.

† See *Aph.* 78.

principally to flourish among the Greeks, was of short duration; and, in the still earlier Ages, the seven wise men, as they were called, all except Thales, applied themselves to moral philosophy, and politics; and when Socrates afterwards brought down philosophy from the heavens to earth, the study of morality prevailed still more; and turned the minds of men from natural philosophy.

Nay, that very period of time, wherein natural enquiries most prevailed, was corrupted, and rendered useless by cavils; and the ostentation of new opinions. And therefore, as through these three periods, natural philosophy was either greatly neglected, or greatly obstructed; 'tis no wonder if mankind made little progress in it, whilst their minds were wholly bent another way*.

80. Add to this, that natural philosophy scarce ever found one, among those who studied it, that gave himself wholly up thereto; especially in these latter times; unless we should here and there except a monk in his cell, or a studious gentleman at his country seat: whence this philosophy has always been but as a passage, and introduction, to other things. And thus the great

* Let care be taken to verify or falsify this account from history as much as possible; wherever it may be required.

mother of the sciences is, with surprizing indignity, degraded to the office of a handmaid; administring to the occasions of medicine or mathematics, and tending the unripe capacities of youth; or giving them their first tincture, for the more commodious and successful attainment of other kinds of learning.

But let none expect any great promotion of the sciences, especially in their effective part, unless natural philosophy be drawn out to particular sciences; and again, unless these particular sciences be brought back to natural philosophy. From this defect it is, that astronomy, optics, music, many mechanic arts, medicine itself; and, what seems stranger, even moral and civil philosophy, and logics, rise but little above their foundations, and only skim over the surfaces and varieties of things; viz. because, after these particular sciences are divided off, and formed, they are no longer nourished by natural philosophy; which might give them new strength and increase: as from the causes and genuine consideration of motions, light, sounds, the texture and structure of bodies, the affections, and intellectual apprehensions. And, therefore, no wonder if the sciences thrive not, whilst they are separated from their roots*.

* This coincides with *Aph.* 79.

81. Another great reason of the slow progress of the sciences, is this; that it is impossible to proceed well in a course, where the end is not rightly fixed and defined. Now the true and genuine end of the sciences, is no other than to enrich human life with new inventions, and new powers; but much the greater number of the sciences produce nothing in this kind; being mere hirelings, and professorial: unless sometimes, by accident, an ingenious artificer, through desire of glory, endeavours after some new invention; which he generally pursues to his own loss; whilst the bulk of mankind are so far from proposing to enlarge the mass of arts and sciences, that they only take from the present collection, or covet so much as they can convert to the use of their profession; their own advantage, reputation, or some such narrow and inferior purpose *. But if any one of the number does ingenuously affect a science for its own sake; yet he will be found to pursue a variety of thoughts and doctrines, rather than a severe and rigid enquiry after the truth. Or if any exact enquirer should turn up; yet even he will propose to himself such a measure of truth, as may satisfy his own mind, in assigning the causes of things already known; and not that which may

* Does not this remain the general case still?

procure fresh pledges and earnests of works, and new light of axioms*. Therefore, since the end of the sciences has not hitherto been well fixed, and defined, by any one; we need not wonder if men have erred and wandered in the things subservient to the proper end.

82. Again; if this end had been rightly proposed; yet men have chose a very wrong and impassable way to proceed in. And it may strike any one with astonishment, who duly considers it, that no mortal should hitherto have taken care to open and prepare a way for the human understanding, from sense, and well conducted experience; but that all things should be left, either to the darkness of tradition; the giddy agitation, and whirlwind of argument†; or else to the uncertain waves of accident, or a vague, and uninformed experience. Let any one soberly and carefully consider, what that way is, which men have accustomed themselves to, in the enquiry and discovery of any thing; and he will, doubtless, find, that the manner of invention most commonly used, is simple and unartful; or no other than this; viz. when a person goes upon an enquiry, in the first place he

* Let the more eminent of the modern inventors, and philosophers, be examined by this rule.

† See above, *Aph.* 10.

searches out and peruses what has been said upon it by others; in the next place, adds his own thoughts thereto; and, lastly, with great struggle of the mind, solicits and invokes, as it were, his own spirit to deliver him oracles *: which is a method entirely destitute of foundation, and rolls wholly upon opinions.

Others may chance to call in the assistance of logic; but this is only a nominal assistance: for logic does not discover the principles and capital axioms upon which arts are built †; but such only as seem agreeable thereto: and when men are curious and earnest with it, to procure proofs, and discover principles, or first axioms, it refers them to faith, or puts them off with this trite and common answer, that every artist must be believed in his own art ‡.

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* This is the theoretical philosopher in his study, who writes with struggle and pains, out of his own invention; instead of consulting nature and experience, which alone afford materials worth the recording.

† See *Aph.* 13, 14, &c.

‡ This having obtained as an almost general rule, the natural and mechanical philosophers, even of the present time, are obliged to resort to artizans, mechanics, and tradesmen, to discover their practices; and learn of the shops what works are performed by art and industry: whereas, if things were in their proper channel; all arts, inventions, and works, should flow from natural philosophers; and life owe those advantages to them, which it now receives from

There remains, therefore, nothing but mere experience; which offering itself, is called accident; but when sought, experiment. And this kind of experience is but like loose twigs*; and a bare feeling about for the right way in the dark; whilst it were much more advisable to wait for day, or light up a flambeau; and then pursue the road†. On the other hand, the true method of experience first procures the light, then shews the way, by its means; beginning with well regulated and digested experiments, (not such as are wild, scattered, and rambling;) and from thence deriving axioms; and, again, from these axioms, well established, sets of new experiments‡. For the divine word itself, did not operate upon the mass of things without order.

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ingenious and inventive mechanics. The consideration hereof seems to have occasioned that noble design of Mr. Boyle, to put a sett of ingenious youths apprentices to several trades; in order, by their communications, and discoveries afterwards, to improve the state of natural philosophy.

* Viz. according to the common expression, a broom or faggot unbound; as having little use, till reduced, from their straggling state, into collections of some form or order, and fit for certain purposes.

† In allusion to the light which the Author, in this work endeavours to set up.

‡ The method in doing this, is shown in the second part

Men, therefore, may cease to wonder that the sciences are no farther advanced; when they have entirely missed the way, and quite forsaken experience; or else, bewildering themselves therein, have coursed about it, as in a labyrinth: for it is a well appointed order, that must lead, in a continued path, through the thickets of experience, to the open plains of axioms.

85. This mischief has obtained a surprizing spread, from a certain opinion, or rivetted conceit, no less tumid than destructive: as if it were a diminution to the majesty of the mind to be long conversant in experiments, and such particulars as are subject to sense, and confined to matter; especially as these things are usually laborious in the enquiry, ignoble in speculation, unpolite in discourse, ungenteel in the practice, infinite in number, and of little sublimity: the issue of all which is, that the true way has not only been forsaken, but also blocked up and obstructed; and experience not only deserted and ill conducted, but disdained*.

84. Again; the reverence of antiquity, and the authority of such as have bore a great re-

* And surely, if natural philosophy has received any improvement of late, it is principally owing to the greater reputation which experience and practice have gained; and the prosecuting, with some tolerable care and order, the business of experimenting, in a variety of subjects.

putation for philosophy, and thence the current consent, has withheld, and almost chained down mankind from advancing the sciences. But of consent we have spoken above *.

The opinion which men entertain of antiquity is a very idle thing; and almost incongruous to the word: for the old age, and length of days of the world, should, in reality, be accounted antiquity; and ought to be attributed to our own times, not to the youth of the world, which it enjoyed among the ancients: for that age, though, with respect to us, it be ancient and greater; yet, with regard to the world, it was new and less. And as we justly expect a greater knowledge of things, and a riper judgment, from a man of years, than from a youth, on account of the greater experience, and the greater variety and number of things seen, heard, and thought of, by the person in years; so might much greater matters be justly expected from the present age, (if it knew but its own strength, and would make trial and apply,) than from former times; as this is the more advanced age of the world; and now enriched and furnished with infinite experiments and observations †.

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* See *Aph.* 77. See also *Aph.* 55

† Let us beware there is no defect in this argument. It is to be apprehended that many of the arts known to the an-

It must also go for something, that by means of the long voyages, and travels, so famous in our times, numerous things have been procured, and discovered in nature, for giving new light to philosophy: and it would be scandalous for mankind to have the tracts of the material globe, its countries, seas, and the heavens themselves, greatly laid open to the view of these times; and yet the intellectual world remain within the narrow confines of the inventions of the ancients *.

'Tis the greatest weakness to be attributing infinite things to authors, whilst we are refusing justice to the author of authors, and all authority; which is time: for truth is justly

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cients, are now lost; particularly the ancient balistics, &c. And even, if all the knowledge and discoveries of the ancients were continued down to us; some will still question, whether the capacities of men in later times are equal to those of former. As to the point of capacity; the Author answers, to avoid dispute, that a cripple in the right way may beat a racer in the wrong; and as to the knowledge of the ancients, he allows it to have been great; and that only some of their more superficial and popular philosophies have descended to us. See above, *Aph.* 71 So that we can only judge of what we have: though the utmost diligence should, doubtless, be used to recover all the arts, inventions, and philosophies that flourished among the ancients.

* So far as we know of them.

called the daughter of time, not of authority. Whence it is no wonder, if these joint fascinations, viz. of authors, of antiquity, and consent, should so far bind the faculties of men as to keep them, like persons possessed, from conversing with things themselves *.

85. And not only the admiration of antiquity, authority, and consent, has constrained the industry of men to acquiesce in things already discovered; but also an admiration of the works they have long possessed. For when a man views that variety and beautiful apparatus of things introduced, and provided by the mechanic arts, for human uses; he is rather inclined to admire the opulency of mankind, than entertain a sense of their want: not considering that the original observations of men, and the operations of nature, which proved like the soul and first mover of all this variety †, were neither numerous, nor derived from any great depth of knowledge; and that the rest was owing only to the patience of men, and the subtile or regular motion of the hand, or instruments. Thus, for example, it is certainly a very subtile and accurate piece of workmanship to make a clock,

* Observe how the Author endeavours to break the charm, mentioned in the preface under *Aph.* 7.

† *Viz.* The observations upon which they were formed.

that shall seem to imitate the revolution of the heavenly bodies, and the pulsation of the bodies of animals, by a regular and successive motion; and yet this depends upon but one or two axioms of nature *.

And if any one shall consider that subtilty shewn in the liberal arts; or the preparation of natural bodies by the mechanic arts, and the like; such, for example, as the discovery of the celestial motions; the notes in music; the letters of the alphabet, (which to this day are not used among the Chinese;) or, again, in the mechanic arts, the productions of Bacchus and Ceres; that is, the preparation of wine, malt liquors, bread, pastery, the furniture of the table, distillations, &c. and if, at the same time, he reflect, through what a number of years all these (except distillation, which alone is not ancient) are arrived to that degree of perfection, wherein we now enjoy them; and yet how little of observation, or of the axioms of nature, they have in them, (as we before instanced in clocks;) and how readily, or, as it were, by obvious occasions, and necessary considerations, they might be discovered; will easily cease his wonder, and rather pity the condition of mankind, that for so many ages there should have been so

* *Viz.* The law of pendulums, suppose, and elasticity.

great a want and barrenness of inventions. Yet all the discoveries now mentioned *, are more ancient than philosophy, and the intellectual arts: so that, to say the truth, when the rational and dogmatical arts came upon the stage, the invention of useful works went off †.

If a man turns his eyes from the shops to libraries, he may perhaps be surprized at the immense variety of books he finds; but upon examining and diligently weighing their matters and contents, he will be struck with amazement on the other side; and after finding no end of repetitions, but that men continually treat and speak the same things over and over again, fall from his admiration of the variety, into a wonder at the want and scantiness of those things, which have hitherto detained and possessed the minds of men ‡.

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* Except distillation, which was excepted before.

† If this, upon a fair and full enquiry, shall appear to be the case; it might afford a strong argument against admitting the rational and dogmatical arts; or any philosophy, but the practical or experimental kind.

‡ Hence the Author, in another place, observes, that there is a great agreement betwixt the shops of artificers, and the libraries of the learned; as both make a great shew of variety, yet contain nothing but infinite repetitions of a few things, or numerous applications of a few principles, differently dressed and modelled, according to particular humours, fashions, and exigencies.

And again; if any one should condescend to regard such things as are accounted rather curious than useful; and take a thorough view of the works of the alchemists, or the followers of natural magic; he might perhaps, be at a difficulty which he should withhold, his tears, or his laughter. For the alchemist goes on with an eternal hope; and where his matters succeed not, lays the blame upon his own errors; and accuses himself, as not having sufficiently understood either the terms of his art, or his author: whence he either hearkens out for traditions and auricular whispers; or else fancies he made some mistake, as to the exact quantity of the ingredients, or nicety of the experiment; and thus repeats the operation without end. And if, in the mean time, among all the chances of experiments, he throws any which appear either new or useful; he feeds his mind with these, as so many earnests; boasts and extols them above measure; and conceives great hopes of what is behind. It must, indeed, be allowed that the alchemists have made many discoveries, and obliged mankind with useful inventions; but they are well represented in that fable of the old man, who left an estate to his children, (buried somewhere or other, he told them, in his vineyard;) which they, therefore, fell to dig for, with great diligence; whereby, though

they found no gold in substance, yet they received a better vintage for their labour.

But such as apply to natural magic, and explain every thing by sympathies and antipathies, have, by supine and indolent conjectures, placed strange virtues and operations in things; and if, at any time, they have produced works, they are rather suited to admiration and strangeness, than to fruit and advantage.

22. And for superstitious magic, if we were disposed to speak thereof, it would come first to be observed, that there is only one certain and determinate kind of subject, in which the curious and superstitious arts, through all nations, ages, and religions, could take place, and have any effect, or impose*. But of this we say no more. In the mean time, it is no wonder if an imagi-

* The Author appears to mean that the weak, and credulous, are this subject. He expresses himself, in another place, thus: The magician, when, according to his own understanding, he sees some things effected that are beyond the power of nature; and thus supposing her to be once forced and subdued; he adds wings to his imagination; and scarce believes the effect to differ according to the degree of more and less; and therefore promises himself that he may obtain the greatest things of all; without considering that they are subjects of one peculiar kind, wherein magic and superstition have had any power and influence, through all nations and ages. See the *Sylva Sylvarum* under the article Imagination and Sympathy.

nation of great plenty has proved a cause of want.

The admiration of mankind, as to doctrine and arts, which is a simple and almost childish thing in itself, has been increased by the craft and artifice of such as treat and deliver the sciences; who propose them with that state and affectation, or so finely fashioned; and bring them so dressed upon the stage, as if they were perfect in every part; and so many finished things. For to look upon the methods and divisions of these teachers, they might seem to contain and include every thing that can fall within the subject; and though the parts are ill filled up, and in reality little more than empty carcasses; yet they pass currently among the vulgar, as having the form and fulness of compleat sciences*.

But the primitive enquirers after truth, with greater fidelity, and a happier conduct,

* This inconvenience is very apt to attend the writing of systems, and bodies of sciencies; where the writer having the matter before him, seldom considers of any thing more than how to give it the best form, and render it most agreeable to the reader. This, though it may usually be esteemed a laudable thing, has yet a pernicious effect, and doubtless retards the advancement of the sciences: whence it should be avoided by philosophers, and severe enquirers into truth, as a kind of imposture. See *Tschirnhaus. Medicina Mentis* in init.

used to throw all the knowledge they determined to collect, and treasure up for use, into aphorisms, or short and loose sentences; not ranged into method; without professing or pretending to set down the whole of an art*. But, as the case now stands, it is no wonder if men make no farther progress in those things, which are delivered as if already perfected.

87. Things of antiquity have also received an additional reputation and credit, from the vanity and levity of such as offered new ones; especially in the effective and operative part of natural philosophy. For certain boasting and fantastical persons, partly through credulity,

* The author thus enforces the present consideration in another place. The first and most ancient enquirers after truth, with more sincerity, and better success, threw the knowledge they gathered from the contemplation of things, and proposed to lay up for service, into aphorisms, or short and independent expressions; which shewing inventions naked as they were, and at the same time indicating the spaces that remained to be filled with discoveries; they were hence the less deceived, and mens thoughts and minds the more excited to judge, and discover. On the contrary, the present method is, to place the sciences in such a light, as may procure them the most credit, not excite the judgment; and, by a severe authority, to stop inventions in the bud: so that the sciences now descend, as in the persons of master and scholar, instead of inventor and improver: whence no wonder if they are not advanced.

and partly through imposture, have amused mankind with great promises of the Prolongation of Life, the Retardation of old Age, the Mitigation of Pain, the Repair of natural Defects, Cures for the Deceptions of the Senses, the way of bending and exciting Affections, the Illumination and Exaltation of the intellectual Faculties, the Transmutation of Substances, the strengthening and multiplying of Motions at Pleasure, the Impressions aud Alterations of the Air, the bringing down and procuring of celestial Influences, the Devination of future Events, the Representation of Things remote, the Revelation of Secrets, &c. The truth is, there seems to be the same difference in the doctrines of philosophy, between these vanities, and the real arts; as there is between the historical narrations of the exploits of Julius Cæsar, or Alexander the Great; and the atchievements of Amadis de Gaul, or Arthur of Britain. For those celebrated emperors are found, in fact, to have accomplished greater things, than the other shadowy heroes are even feigned to have done: and yet this, by such means as are no way fabulous or monstrous. Nor should it detract from the credibility of real history, that it has sometimes been injured and abused with fables. In the mean time, it is not strange that a great prejudice should be rais-

ed against new proposals, especially those relating to works, upon account of these impostors, who have attempted the like; whence the excess and disdain of vanity *, have, even at present, left no spirit for such great designs †.

88. But the sciences have been much more hurt by pusillanimity, and the slenderness of the tasks which men proposed themselves; and yet, to enhance the mischief, this pusilanimity is not without its pride and disdain.

For first, it is a common excuse with every artist, to lay the imperfection of his art, as a reproach, at the door of nature; and what his art does not perform, to pronounce, from that art, impossible in the nature of things; and certainly the art will not be condemned, whilst itself is the judge. Nay, the present philosophy contains and patronizes some opinions, which, if diligently examined, wholly tend to persuade mankind, that nothing great, or very commanding over nature, can be expected from art, or the human powers, (as we instanced above, in the difference

* Viz. excess on one side, and disdain on the other: or on the side both of projectors, and anti-projectors.

† And under this disadvantage the author lay in his great designs, for enriching the kingdom by mineral works; erecting his Solomon's College; his enquiries for prolonging life; commanding the winds, and the weather; his new logic, &c. &c.

betwixt solar and culinary fire, composition, mixture, &c.*) which, in the result, is no other than maliciously to limit men's faculties; and to invent, and introduce, an artificial despair, that shall not only disturb and unsettle our hopes and expectations, but take away the motives to industry, cut its sinews, and disappoint or prevent all the chances of experience; whilst the artist is only solicitous about this, that his art should be esteemed perfect, thus endeavouring at an exceeding vain and destructive glory, in having it believed, that every thing not yet discovered and understood, is absolutely impossible to be found out, or known†. And if any one applies himself to nature, and endeavours to strike out something new, yet he will generally propose and fix upon some one invention, without farther search: For example, the nature of the loadstone, the tides, the theory of the heavens, and the like; which seem to conceal some secret, and have been hitherto unsuccessfully explained; whereas it is, in the highest degree, unskilful to examine the nature of any thing in that thing itself. For the same nature which in some

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* See *Aph.* 75.

† Some will confine this to the more illiterate mechanics and artisans, and others extend it to the liberal sciences, medicine, philosophy, &c.

things lies hid and concealed, appears open and obvious in others, so as to excite admiration in the one, and to pass unobserved in the other; thus the nature of consistence is not taken notice of in wood or stone, but slighted under the term of solidity, without farther enquiry into its avoidance of separation, or solution of continuity; whilst the same thing appears subtile, and of deeper enquiry, in bubbles of water, which throw themselves into thin skins, of a curious hemispherical figure, in order, for the instant, to avoid a solution of continuity.

And, again, those very things which are accounted secrets, have, in other cases, a common and manifest nature, which can never be discovered whilst the experiments and thoughts of men run wholly upon them*. And generally those things are esteemed new inventions in mechanical works, that are no more than better ways of finishing, adorning, joining, compounding, rendering more commodious, enlarging, or contracting the bulk of the old ones, and the like†.

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* Thus transmutation, though expressly endeavoured after, to little purpose in some cases, yet in others seems to occur almost spontaneously. See *Sylva Sylvarum*, under the articles Alterations and Transmutations.

† In another place the Author observes, that if a mechanic happens to add some ornament, and a greater lustre, to

So that it is no wonder if noble and worthy inventions, suitable to the dignity of mankind, are not brought to light, whilst men content and please themselves with such slender and childish performances, and at the same time imagine that they perform great matters by them.

89. We must not omit, that natural philosophy has, through all ages, had a troublesome and difficult adversary to contend with, viz. superstition, and the blind, furious zeal of religion. For we find among the Greeks, that they who first assigned the natural causes of thunder and storms, whilst the ears of men remained unaccustomed to such explanations, were condemned for impiety against the gods*. Nor did those meet with much better fate, from some

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any former invention, or combines two or three things that before were separate, or fits them more commodiously for practice, or exhibits the thing either in a greater or a less bulk, he presently writes himself in the list of inventors; whence men 1. disdain the invention of new arts and works, as an idle, fruitless, and suspected endeavour; or, 2. believe that there are noble inventions discovered, but that they lie concealed, with the utmost silence and caution, in a few hands; or, 3. take these smaller additions and alterations of invention for new discoveries. All which tends to turn men's minds aside from the true and laborious method of enquiry, and prevents such tasks and discoveries as are worthy of mankind.

* See the Clouds of Aristophanes.

eminent fathers of the Christian church, who, upon infallible demonstration, which no man in his senses would now oppose, asserted the spherical figure of the earth, and consequently the existence of antipodes.

And, as matters now stand, it is still more difficult and dangerous to discourse upon nature, by reason of the summaries and methods of the scholastic divines, who having imperiously reduced theology to order, and fashioned it into an art, have, at the same time, blended too much of the thorny and contentious philosophy of Aristotle into the body of religion.

And to this head belongs, though in a different respect, the labours of such as have ventured to deduce and confirm the truth of the Christian religion, from the principles and authorities of philosophers, thus, with great pomp and solemnity, celebrating the inter-marriage of faith and sense, as a lawful conjunction, and soothing the minds of men with a pleasing variety of matter, though at the same time rashly and unequally intermixing things divine and human. But in such medlys of divinity and philosophy, only the things at present received in philosophy are comprehended, whilst new ones, though better, are almost quite rejected and excluded.

Lastly, we find, through the unskilfulness of certain divines, that the passage to any philoso-

phy, though ever so just, is in a manner blocked up; for some weakly suspect, that deep enquiries into nature will transgress the bounds of sobriety; and injudiciously wresting what is said in scripture of those who pry into the divine mysteries, apply it to the secrets of nature, from which we are no where forbid. Others, with greater cunning, conceive, that if the means remain unknown*, all things may be the easier managed by the dexterity of the hand, and the divining rod, which they imagine highly serviceable to religion; but this is no other than offering to God the unclean sacrifice of a lye†. Others dread the example, lest the disturbances and changes in philosophy should extend to, and terminate in religion. And others, again, seem afraid, lest something should be found in the enquiry of nature to subvert, or at least undermine religion, especially among the ignorant. These two latter fears appear to us to be deeply tinged with low groveling wisdom, as if men, in their secret thoughts, cherished some doubt and distrust about the strength of religion, and the power of faith over the senses, and therefore apprehend danger to it from the search of truth in

* *Viz.* If men are kept in ignorance.

† For knowledge can never make men irreligious, or independent upon God.

natural things; but whoever rightly considers it, will find, that natural philosophy is, next after the word of God, the most certain cure of superstition, and the best support of faith. Philosophy, therefore, is deservedly appointed as the true handmaid to religion; the one manifesting the will, and the other the power of God. For it was no error in him who said, *Ye err, not knowing the scriptures, and the power of God;* thus inseparably mixing, and joining together the information of his will, and the knowledge of his power. It is, therefore, the less wonder, that natural philosophy has been so little improved, when religion, whose power over men's minds is exceeding great, has, through the ignorance and unwarrantable zeal of some, been made to oppose it.

90. Again, in the customs and institutions of schools, universities, colleges, and the like conventions, destined for the seats of learned men, and the promotion of knowledge, all things are found opposite to the advancement of the sciences; for the readings and exercises are here so managed, that it cannot easily come into any one's mind to think of things out of the common road. Or if here and there one should venture to use a liberty of judging, he can only impose the task upon himself, without obtaining assistance from his fellows; and if he could dispense

with this, he will still find his industry and resolution a great hindrance to the raising of his fortune. For the studies of men in such places are confined, and pinned down to the writings of certain authors; from which, if any man happens to differ, he is presently reprehended as a disturber and innovator. But there is surely a great difference between arts and civil affairs; for the danger is not the same from new light, as from new commotions. In civil affairs, it is true, a change even for the better is suspected, through fear of disturbance; because these affairs depend upon authority, consent, reputation, and opinion, and not upon demonstration: But arts and sciences should be like mines, resounding on all sides with new works, and farther progress. And thus it ought to be, according to right reason; but the case, in fact, is quite otherwise. For the above-mentioned administration and policy of schools and universities, generally opposes and greatly prevents the improvement of the sciences.

91. And though this contrariety should cease, yet it is sufficient to check the progress of the sciences, that such endeavours, and such industry, are not rewarded*; for those who cultivate the sciences, have not the power of rewarding.

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* See above, *Aph.* 90.

The improvement of the sciences proceeds from great capacities, but the salaries and rewards for them lie in the hands of the vulgar, or such rulers of state as are rarely men of considerable learning. And what is more, such kind of advancement not only fails of reward and encouragement, but is destitute even of popular praise, as being above the reach of the crowd, and easily beat down and extinguished by the winds of vulgar opinion. Whence, again, it is no wonder that this business has proceeded no better, whilst, instead of encouragement, it has met with disesteem.

92. But the greatest obstacle of all to the progress of the sciences, and the undertaking of new tasks and provinces in them, lies in the despair of mankind, and the supposition of impossibility. For prudent and exact men generally distrust such kind of attempts, upon considering with themselves the obscurity of nature, the shortness of life, the fallacy of the senses, the weakness of the judgment, the difficulties of experimenting, &c. Whence they conceive, that there are certain ebbings and flowings of the sciences, through all the revolutions of times and ages, so as one while to increase and flourish, and another to decline and lie neglected; and, when arrived at one certain state and degree, to become uncapable of rising higher. Therefore, if any man

should hope or undertake for the contrary, they think it the sign of a weak and unripened judgment; and that such attempts begin with pleasure, proceed with difficulty, and end in confusion.

And as these are thoughts which readily occur to grave and judicious men, we must indeed beware, lest being ourselves caught with the love of a thing that has an excellent and beautiful appearance, we should slacken the reins of judgment. We shall, therefore, next proceed, with care, to examine what degree of hope there is of future success, and from what quarter it arises; (with the purpose of rejecting the lighter gales thereof,) and diligently discuss and weigh those grounds that appear the strongest. And here civil prudence also is to be consulted, which distrusts by prescription, and suspects the worst of human affairs*. And whilst we thus enquire into the grounds of hope, we ourselves make no promises, offer no violence to the mind, and lay no snares for the judgments of men, but only lead them by the hand.

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* See above, *Aph.* 75.

SECTION VI.

OF THE GROUNDS OF HOPE, FOR THE FARTHER ADVANCEMENT OF PHILOSOPHY AND THE SCIENCES.

93. THOUGH the most powerful motive of hope will hereafter be delivered, (when we shall lead mankind to particulars, especially as we propose to digest and range them in our tables of invention, which principally belong to the fourth part of our general design) where things themselves, rather than hopes, will be offered; yet, that all may be done in the smoothest manner, we shall here proceed in our purpose of preparing the minds of men. And in giving them a view of the hope there is for improving the sciences, consists no small part of this preparation; as, without it, all the rest has a greater tendency to deject mankind, than to raise them to a chearful and industrious prosecution of experiments, and only give them a meaner opinion of the things they at present enjoy, and a deeper sense of their own misfortune. We shall, therefore, here open and propose our conjectures, for rendering the more favourable expectations of the sciences probable, in imitation of Columbus, who, before he undertook his surprising expedition through the Atlantic ocean, produced his

reasons why he expected to find new lands and continents, besides those that were then discovered: which reasons, though at first rejected, yet being afterwards confirmed by experience, were the cause and origin of very great things.

We begin with God, the Author of all good, and the Father of lights, from whom the goodness of this design manifestly shews it to proceed. We see in the divine works, that the smallest beginnings are certainly succeeded by the effects. And what is said of spiritual things, that the kingdom of God comes not with observation, is also found true in every great work of divine Providence, where all things go quietly on, without noise or bustle, so that the whole is accomplished, before men imagined or took notice that it was in hand. And we should here remember the prophecy of Daniel, concerning the latter ages of the world: *Many shall go to and fro upon the earth, and knowledge shall be increased;* thereby plainly intimating it to be the design of Providence, that when the world was laid open to a general intercourse, as by our numerous long voyages it now begins to be, at the same time also the sciences should receive increase*.

* We may now be enabled, in some measure, to judge how far these grounds of hope were solid and well laid. Certainly a great revolution in philosophy has gradually ensued upon the endeavours of the Author; and philosophers

94. A capital reason of our hope, may be also derived from the errors of past times, and the ways that still remain untried. The following reprehension of a civil state, that had shewn little conduct in its affairs, is excellent*. "What, "with regard to times past, is the worst, should, "for the time to come, be esteemed the best. "For if you had performed your duty to the "full, and yet your affairs had gone backwards, "there would have been no hopes of their "amendment; but, as the bad posture of your "affairs proceeds, not from necessity, but from "your own errors, there is room to hope, that "when those errors are forsaken, or corrected, "a great change for the better may ensue." In like manner, if mankind had, for so many ages, held on in the true course of discovering and improving the sciences, and yet could have advanced them no higher, it would indeed be bold and presumptuous to believe them capable of farther improvement; but if the way itself has been mistaken†, and the labour of mankind been bestowed where it ought not, it follows that

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have been insensibly drawn off from speculation and theory, to practice and experience, whence many useful inventions and works have proceeded, and more may, perhaps, proceed.

* The reprehension of Demosthenes to the Athenians.

† See above, *Aph.* 81, 82, 83, &c.

the difficulty does not arise from hence, that things lie out of their reach, but from the understanding itself, its manner of use, and application, which may still be remedied*. It were, therefore, adviseable to enumerate these very errors, for so many impediments as past errors have proved, so many arguments there are of future hope. And though we have already touched upon them above†, yet we think proper here again to represent them in a concise, naked, and simple manner.

95. Those who have treated the sciences were either empirics or rationalists. The empirics, like ants, only lay up stores, and use them; the rationalists, like spiders, spin webs out of themselves; but the bee takes a middle course, gathering her matter from the flowers of the field and garden, and digesting and preparing it by her native powers. In like manner, that is the true office and work of philosophy, which, not trusting too much to the faculties of the mind, does not lay up the matter, afforded by natural history and mechanical experience, entire or unfashioned, in the memory, but treasures it, after being first elaborated and digested in the understanding; and, therefore, we have a good ground

* See hereafter, *Aph.* 105, 106. and *Part* II. throughout.
† *Sect.* V. *Aph.* 78—92.

of hope, from the close and strict union of the experimental and rational faculty, which have not hitherto been united *.

96. Natural philosophy is not hitherto found pure, but infected and corrupted, in the school of Aristotle, by logic; in that of Plato, by theology; in the second school of Plato, Proclus, and others, by mathematics, which ought only to terminate natural philosophy, and not to generate or create it *. And, therefore, we have

* The Author, however, cautiously observes in another place, that there have been some empirical philosophers, who would not be esteemed merely empirical; and, again, some rationalists, who desired to appear industrious, and versed in experience; but that this was only the artifice of certain men, in endeavouring to raise themselves a character and reputation, for excelling in their different sects, whilst, in reality, the two faculties were ever separated, and almost opposed to each other.

† Here seems to be a direction of great moment, for the advancement of genuine philosophy, which certain men conceive cannot be so effectually promoted as when mathematics presides therein, and directs. But this should be farther considered, and without all partiality to mathematics; for the logician would have his art preside in philosophy, the chemist his, and the metaphysician is apt to reduce all to abstraction and ideas. Certainly philosophy should refuse none of these helps; but to make choice of any one of them, so as to exclude the rest, must needs occasion a partial philosophy. And hence the chemical philosophies, the logical philosophies, the metaphysical philosophies, and even the mathematical philosophies, cannot, perhaps, be safely depended upon.

another ground of hope, from a natural philosophy pure and unmixed.

97. No man has yet appeared, of so great constancy and firmness of mind, as to impose upon himself the total extirpation of theories, and common notions, and offer the understanding quite plain and smooth, to receive particulars anew; and, therefore, that knowledge we have is nothing more than an undigested heap and collection of much faith and accident, mixed with abundance of childish notions, imbibed in our youth*.

Whence, if any one of riper years, sound in his senses, and of a clear, unbiassed mind, were to apply himself afresh to experience and particulars, better things might be expected from him. And in this respect, we promise ourselves the fate of Alexander the Great. But let us not presently be accused of vanity, before the end of the story be heard, which regards the laying aside of all vanity.

For Æschines, speaking of Alexander and his exploits, has these words. "Surely we lead no "mortal life, but are born to this end alone, "that posterity should relate strange things of "us." As if he esteemed the atchievements of Alexander miraculous. But Livy coming, long afterwards, to consider, and look better into the

* See above, *Aph.* 19, 27, 28, 29.

thing, said of it, that "Alexander did no more than dare to despise vanities." And such a judgment we expect posterity will pass upon us, viz. that we have done no great matter, but only esteemed those as little things which were accounted great ones. In the mean time, there is no hope, as we before observed, but in the regeneration of the sciences, or the raising and building them up anew, in a certain order, from experience, which no one, perhaps, has hitherto attempted or thought of*.

98. And for the foundations of experience, which is the next thing we must proceed to, they either have not hitherto been laid, or very weakly. Nor has a collection of materials, competent either in number, kind, or certainty, for informing the understanding, or any way sufficient, and worthy of the end proposed, been hitherto made; but, on the contrary, learned men, after an easy, indolent manner, have received certain rumours of experience, and the popular reports and tales thereof, both for building and strengthening their philosophy, and given them the

* Let antiquity be farther searched upon this head, as also the Chinese history, and the histories of other ancient nations consulted, to see if nothing of this kind was ever proposed before. What the Author means, will fully appear hereafter, under *Sect.* VII. but more particularly in the Second Part of this work. See also above, *Aph.* 21.

weight of strong testimonials, which is just as if a kingdom should govern itself, not according to the advices and intelligences of its ambassadors, and trusty officers in foreign courts, but by the idle rumours, and common town-talk of its people. For as to matter of experience, there is nothing hitherto well discovered, verified, adjusted, weighed, or measured, in natural history, but whatever is undefined and vague in observation, must needs be fallacious and deceitful in the information. And if this shall seem suprizing, or the complaint appear unjust to any one, whilst so great a philosopher as Aristotle, assisted with the purse of so great a prince as Alexander, has compiled such an exact history of animals; and whilst some others, with greater diligence, though with less bustle, have contributed many things thereto; and whilst others again have wrote copious histories, and accounts of plants, metals, and fossils, he does not seem sufficiently to understand our meaning. A natural history, compiled for its own sake, is one thing; and a natural history, collected for informing the understanding, in order to the building up of natural philosophy, is another. And these two histories, as they differ in other respects, so principally in this, that the former contains various descriptions of natural bodies, but not experiments of mechanic arts. For as, in civil life, the temper of a man, and the secret dispositions of his mind and affections, are

better understood, when he is ruffled, than otherwise; so the secrets of nature are better got out by the torturing of arts, than when suffered to take their own course. And, therefore, we may then have good hopes of natural philosophy, when natural history, which is the basis thereof, shall be better supplied, and not before.

99. Again, in the very stock of mechanical experiments, there is a great want of such as principally conduce to the information of the understanding. For the mechanic, being no way concerned about the discovery of truth, applies his mind, and stretches out his hand, to nothing more than is subservient to his work; but we may then rationally expect to see the sciences farther advanced, when numerous experiments shall be received and adopted into natural history, which of themselves are useless, and tend only to the discovery of causes and Axioms; these being what we call experiments of light, to distinguish them from experiments of profit. And they have this wonderful property, that they never deceive or frustrate the expectation; for being used, not in order to effect any work, but for disclosing of natural causes, in certain particulars; let them fall which way they will, they equally answer the intention, and solve the question.

100. And not only a larger stock of experiments is to be sought, and procured, of a different kind from what has hitherto appeared, but also a quite different method, order, and procedure, is to be introduced, for continuing and advancing experience itself; for vague experience, that pursues nothing but itself, is, as was before observed, a mere groping about in the dark*, and rather amazes mankind, than informs them. But when experience shall be conducted by certain laws, orderly and consequentially, we may have better hopes of the sciences.

101. And when a proper quantity of suitable materials, for such a natural and experimental philosophy, as is required for the work of the understanding, or the business of philosophy, shall be provided and got ready, yet the understanding is no way qualified to act upon these materials spontaneously, and by memory, no more than a man should expect to make the calculations for an almanack, by the bare strength of his memory. Yet contemplation has hitherto been more employed in invention than writing, nor is experience yet made learned. But no invention should be allowed, or trusted, except in writing. And when this comes into use, so

* See above, *Aph.* 82.

that experience may be made a matter of learning and science, we may then have better hopes*.

102. Again, the number, or, as it were, the army of particulars, being so large, scattered, and confused, as to distract and confound the mind, little good can be expected from the skirmishes and sallies of the understanding, unless it be fitted, and brought close to them, by means of proper, well-disposed, and actuating tables of invention, containing such things as belong to the subject of every enquiry; and unless the mind be applied to receive the prepared and digested assistance they afford†.

103. And even when a stock of particulars is exactly and orderly placed before us, we must not immediately pass on to the enquiry and dis-

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* The caution here laid down is extremely necessary, for the natural powers of the mind are so infirm and weak as by no means to be trusted in the business of invention, observation, or experiment. We see it is common for men, after some time, to forget their own observations and experiments. Nor is the memory sufficiently ready and apt to present things as they may be wanted; nor the judgment always clear, strong, and in right order. So that even natural things, whilst they dwell only in the memory, or imagination, seem little better than phantoms, and require to be distinctly wrote down, for the service of philosophy. See hereafter, *Part* II. *passim*.

† See hereafter, *Part* II. *Sect.* I.

10820

covery of new particulars or works, at least if this be done, we must not dwell upon it. We deny not, that after all the experiments of every art shall be collected, digested, and brought to the knowledge and judgment of a single person, many new discoveries may be made, for the use and advantage of life, through the translation of the experiments of one art into another, by means of what we call learned experience; yet less hope is to be conceived hereof, and a much greater of a new light of Axioms, drawn regularly, and in a certain manner, from those particulars, so that such Axioms may again point out, and lead to new particulars. For the way lies not through a plain, but through mountains and valleys, first ascending to Axioms, and then descending to works*.

104. But the understanding must not be allowed to leap, or fly from particulars, to remote, or the most general kind of Axioms, at once, (such as are called the principles of arts and

* This will be more fully explained in the Second Part. The Author intended to treat of the ascending and descending Scale of Axioms, as a part of the present work, but it was never published. And as this method has not, that we know of, been hitherto tried, it affords an argument of hope, that philosophy and the sciences may be improved by its means.

things*,) and so prove, and draw out middle Axioms, according to the established truth of the former, as has hitherto been done by a natural sally of the understanding, which is naturally inclined this way, and has been long trained and accustomed to it, by the use of those demonstrations which proceed upon syllogism†. But we may conceive good hopes of the sciences when, by continued steps, like real stairs, uninterrupted or broken, men shall ascend from particulars to lesser Axioms, and so on to middle ones; from these again to higher; and, lastly, to the most general of all. For the lowest Axioms differ not much from bare experience‡, and the highest, and most general ones, as they are now esteemed, prove only notional, theoretical, and of no solidity, whilst the middle Axioms are the real, the solid, and animated kind, wherein the affairs and fortunes of men are placed§; and above these, come such as are

* Suppose the fiction of the Four Peripatetic Elements, which have been made the basis of natural philosophy; the salt, sulphur, and mercury of the chemists; the *Fuga Vacui*, &c.

† See above, *Aph.* 13, 14, 19, 20, 25, &c.

‡ Such as in chemistry, that animal substances yield no fixed salt, by calcination; in music, that concords, intermixed with discords, make harmony, &c.

§ Such as in optics, that the angle of incidence is equal to the angle of reflexion, in all sorts of surfaces; in physics Sir Isaac Newton's three laws of motion, &c.

truly the most general, yet not metaphysical, but justly limited by these intermediate ones*.

And, therefore, the understanding does not want sail so much as ballast, to keep it from skipping and bounding; but as this is hitherto a desideratum, when it shall be supplied we may have better hopes of the sciences.

105. Again, a different form of induction from what has hitherto been used, must be invented for the raising of Axioms, and that not only for the discovering and proving of principles, as they are called, but likewise for ascertaining the lesser, middle, and, in short, all kinds of Axioms. For that induction which proceeds by simple enumeration, is a childish thing, concludes with uncertainty, stands exposed to danger from contradictory instances, and generally pronounces upon scanty data, and such only as are ready at hand†; but the induction useful in the discovery and demonstration of arts and sciences, ought to sift nature by proper rejections and exclusions, and then conclude upon affirmatives, after the due number of negatives are thrown out, a thing never yet done, nor attempted, unless by

* The highest sort may be called Axioms of Axioms, and were intended to have been treated at large by the Author; but it should seem that philosophy in the general, or the Author's method in particular, has not been so far prosecuted as to afford them.

† See above, *Aph.* 13, 17, 19, 20, 24, 25, &c.

Plato, who made some little use of this form of induction in the sifting of definitions and ideas*. But for the just and regular forming of this induction, or demonstration, numerous particulars are required, which have been hitherto thought of by no mortal, so that greater pains must be bestowed upon it, than has been bestowed upon syllogisms. And the assistance of this induction must be used, not only for the discovering of Axioms, but also for the defining of notions†. And in this business of induction is lodged the greatest hope of improving the sciences.

106. But in forming these Axioms by this induction, it must be well examined and tried whether the Axiom intended be only adapted, and made according to the measure of those particulars from which it is extracted, or whether it be larger, and extend beyond them‡. If it be

* See above, *Aph.* 71. This business of Induction is farther explained in another place, thus: Such a form of Induction may be introduced, as to draw some general conclusion from certain particulars, so as at the same time to demonstrate, that no contradictory instances can be found, for otherwise we might easily pronounce upon too few particulars, and these also of the obvious kind.

† See above, *Aph.* 19. See also *Part* II. *Sect.* I. *passim.*

‡ These are the Axioms which the Author principally intends, viz. not such as shall be made to fit a few particular instances, which are no more than naked expressions of the result of certain facts, but such as shall far exceed the parti-

more extensive, regard must be had whether it confirms its own extensiveness, by promising well, that is, by designing or pointing out new particulars, lest otherwise we should either stick in things already known, or else, with a weak endeavour, catch at shadows and abstract forms, and not grasp such things as are solid, and fixed in matter*. And when this practice shall take place, a solid hope will justly attend it.

107. And here should be repeated what we said above, concerning the extending of natural philosophy, and the bringing particular sciences back again thereto†, so as to prevent all rending and dismembering of the sciences. For, unless this be done, there is less hope of their farther advancement. And so much for preventing despair, and exciting hope, by way of forsaking or rectifying the errors of times past. We proceed next to consider what other motives of hope are still behind.

108. And, first, since many useful things have been discovered, as it were by accident or necessity, without any enquiry, or particular regard on the side of men, there can be no doubt, but if

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culars from whence they were drawn, mark out new particulars, and lead to greater discoveries.

* The meaning of this is largely explained in the Second Part of the present work.

† See above, *Aph.* 80.

men were to look out, and bend their minds to it in a certain method and order, and not by fits and starts, that many more discoveries would be made. For although it may now and then happen that a man shall accidentally hit upon a thing which had before escaped a great and diligent search, yet, questionless, the contrary is found in the whole of things; and, therefore, many more, and much better discoveries, are to be expected from the reason and industry, the direction and intention, of mankind, and that in less time than from chance, the instinct of brutes, &c. which have hitherto given the first hints of discoveries *.

109. It may likewise be an argument of farther hope, that some of the things already discovered are such as, before their discovery, did not enter into men's minds even to suspect, so that any one would have despised them as impossibilities. For it is an usual way with mankind to form conjectures of new things, according to the examples of old ones, and according to the opinion thence preconceived and entertained, which is a very fallacious manner of judging, for many particulars derived from the fountains, or origins of things, do not flow in the common channels †.

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* See above, *Aph.* 74—85. † See above, *Aph.* 24.

So if a man, before the discovery of ordnance, should have thus described the thing by its effects, viz. that there was a certain way of battering down walls, and the strongest fortifications, at a great distance, men's thoughts would have run upon multiplying the force of their common engines of war, the known battering-rams and machines, by the means of weights, wheels, and the other mechanical powers, but scarce any one would have suddenly fallen upon the invention of raising a fiery wind, that should blow out of a tube with such prodigious, expansive violence, as to produce the above-mentioned effect; an obvious example thereof having never been seen, unless perhaps in earthquakes or thunder storms, which, as being grand works in nature, men would presently have rejected as inimitable by art*.

So likewise, before the invention of silk, if any one should have said there was a certain way of making a certain cloth for apparel, and household furniture, far exceeding that of linen, or of woollen, in fineness, strength, gloss, and softness, men would immediately have fallen to conjecturing about some vegetable silk, the finer furs of animals, or the feathers and down of birds,

* It cannot be too carefully remembered, that all our knowledge is in proportion to what we have seen, and not to what is contained in nature.

without ever dreaming it should proceed, in such plenty from the anniversary spinning of a small worm. And if any one should have but dropped a word about such a worm, he would certainly have been laughed at, as the projector of a new spider work.

So again if, before the use of the compass, any man had said that a certain instrument was known for exactly discovering the quarters and points of the heavens, men's invention would hence presently have run upon more exact construction of astronomical instruments, and various ways of applying them; but that any thing should be found, whose motion had such a correspondence to the heavenly bodies, and yet the thing itself be no celestial, but only a bare terrestrial, stony, or metallic substance, would have seemed absolutely incredible. Yet these, and the like particulars, have been hid from mankind for so many ages, and at last were not discovered by philosophy, or the rational arts, but by chance or accident, and are of such a nature as to appear perfectly foreign and remote from the things known before, so that no previous notion could any way lead to them.

Whence there is great room to expect, that there still remain in the bosom of nature many things of excellent use, that have no manner of relation or analogy to the things already disco-

vered, but lying perfectly out of the road of the imagination*, and which, though hitherto unknown, may doubtless, through numerous revolutions and successions of ages, be one time or other discovered, as those abovementioned have been. But, by the method we propose, they will more readily and suddenly be represented and anticipated †, at once‡.

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* Such as the bark, and other specifics, in medicine; phosphorus, aqua fortis, and aqua regia, in chemistry; the use of lead and antimony, in refining, &c.

† That is, be discovered, or at least foreseen in the mind, and the ways of bringing them into use discerned, much sooner than by waiting the ordinary, or slow-paced course of things, as is shewn in the Second Part.

‡ The following Aphorism, found detached in another place, may deserve to be added here.

1. "It may, perhaps, seem incredible to many, that "there should still remain undiscovered any considerable "number of useful and beneficial works; and, again, "stranger that they should hereafter be discovered of a "sudden; and great, to be sure, will be the wonder what "these particular works can be. The direct answer is, "that as the ignorance of mankind has led them into de-"spair, so knowledge will lead them out of it, into the re-"gions of hope, or rather of certainty. But whoever duly "considers it, will not find it strange, if our method of in-"terpreting nature prevails, that there should, in a small "compass of time, many new and useful inventions grow "up, for the births of knowledge are quick, but the births "of time are slow. And all the noble inventions at pre-"sent in use, rather proceeded from accident, and random

110. There are also other inventions of such a kind as to shew that men may pass by and over-

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" trials, or conjectures, than from any previous light of " knowledge; whereas the method of discovering by In- " duction is certain, regular, and direct, without waiting " for accidental hits, and lucky chances.

2. " And, that there may still remain new discoveries to " be made, at least with regard to ourselves, may be fairly " argued from hence, that we have no certain knowledge " of all the inventions known to former ages, the different " countries of the world, or to all particular persons. And " it is certain, were it not for men, we should never have " seen multitudes of those things we at present enjoy, espe- " cially those vulgarly called productions of art, such as " cloth, coin, &c. And, to consider it closely, mankind " will be found directed by certain motions, which they " obey in their discoveries. These motions, indeed, ap- " pear subtile, and hard to be distinctly comprehended and " understood, but are not the less certain for that. And " though, in this case, men may be said to obey their own " will, that alters not the nature of the thing; for will, in " man, acts like that called fortune, or accident, in the " world. Such things, therefore, as require the assistance " of men to produce, and have hitherto lain quite out of " their road, may be reasonably expected from this new " method, which was unknown to former ages. For men " sometimes stumble upon things before they are aware of " them, and go in quest of others with a certain view, and " such means as they know; but the knowledge of the " means for discovery has hitherto come by common ob- " servations and obvious experiments, whereas our method " tends to produce such works as have neither an obvious " effect, an obvious operation, nor an obvious light, being

look noble discoveries which lie before their feet. For though the invention of gunpowder, silk, the compass, sugar, paper, &c. may seem to depend upon certain properties of things, and of nature, yet doubtless the art of printing contains nothing that is not open, and in a manner obvious. But men not observing, that though it were harder to range the types of letters than to draw letters by the hand, yet there was this difference, that the types of letters, being once set, would serve for numerous impressions, whilst characters, drawn by the hand, afforded only a single writing; or, perhaps, not reflecting that ink might be so thickened as to stain without flowing, especially if the face of the letter stood upwards, and the impression was struck downwards; the world has, for so many ages, been without this admirable invention, which so nearly concerns the propagation of knowledge.

And, in this course of invention, the mind is frequently so perverse, childish, and contradictory, as first to distrust, and presently after to despise itself; for men first conceive it incredible that any such discovery should be made, but after it is once made, they again think it incredi-

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"indeed no other than the works of knowledge, that are "not otherwise producible than by pure science and direct "interpretation, neither of them obvious, but removed in-"finite degrees from such things as are common."

ble that it was not found out before. And hence we justly deduce another ground of hope, that there may still remain a large treasury of inventions, deducible not only from the unknown operations to be hereafter discovered, but also from transferring, compounding, and applying those already known, by the means of what we call learned experience.

111. As a farther ground of expectation, men may please to consider the infinite expence of genius, time and treasure, that has been bestowed upon things and studies of very little use and value, whilst if but a part thereof were employed upon sound and serviceable matters, every difficulty might be conquered. And this we thing proper to mention here, because we must confess that such a collection of natural and experimental history, as we have measured out in our mind, and such as really ought to be procured, is a great and royal work, requiring the purse of a prince, and the assistance of a people.

112. And let no man shrink at the multitude of particulars required, but turn this also to an argument of hope. For the particular phænomena of arts and nature are all of them like sheaves, in comparison of the inventions of genius, when disjoined and metaphysically separated from the evidence of things. The former

road soon ends in an open plain, whilst the other has no issue, but proves an infinite labyrinth; for men have hitherto made little stay in experience, but passed lightly over it; and, on the other hand, spent infinite time in contemplation and the inventions of genius, whereas, if we had any one at our elbow who could give real answers to the questions we should put about nature, the discovery of causes, and of all the sciences, would be a work but of a few years*.

113. We judge also, that mankind may conceive some hopes from our example, which we offer, not by way of ostentation, but because it may be useful. If any one, therefore, should despair, let him consider a man as much employed in civil affairs as any other of his age, a man of no great share of health, who must therefore have lost much time, and yet, in this undertaking, he is the first that leads the way, unassisted by any mortal, and stedfastly entering the true path that was absolutely untrod before, and submitting his mind to things, may thus have somewhat advanced the design. And after this, let him who desponds consider what may be expect-

* It may here add some weight to find that general scholar, Dan. Geor. Morhof of opinion, that the Author himself was equal to the interpretation of all nature, if he had not been prevented by civil business. See Morhof. Polyhist. Tom. ii. p. 381.

ed from men of leisure, a conjunction of labours, and a succession of times, proceeding upon the notices we have given them, especially as it is in a way not open only to certain persons, as the rational way is*, but where the labours of all men, especially in the collecting of experiments, may be well distributed, employed, and afterwards joined together. For then it is that mankind will begin to know their own strength, when not infinite numbers shall perform the same things, but some execute one thing, and some another.

114. Lastly, although a much weaker and fainter breeze of hope should breathe from the new continent†, yet we must absolutely determine for the business of experimenting, unless we had rather be quite abject and desponding. For it is not equally dangerous to refuse trying, and not to succeed, because trial has a chance of procuring a great advantage, and failure the chance but of a small loss of labour. To sum up all; it appears to us, both from what has been said, and what remains unsaid, that there is hope sufficient, not only for a man of courage

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* See above, *Aph.* 95.

† The future prospect of improving the sciences.

to try, but also for a prudent and sober man to believe *.

115. And thus much by way of removing despair, (which is a principal cause of the slow progress of the sciences) at the same time finishing what we had to offer concerning the signs and causes of errors, and the prevailing indolence and inactivity of men; for as to the more subtile causes, which come not under popular judgment or observation, they should be referred to what we have said above concerning the Idols of the Mind †.

And here likewise must end that part of our work which regards the pulling down of the old structure, and which is effected by three kinds of confutation, viz. 1. the confutation of the natural reason when left to itself; 2. the confutation of the manner of demonstrations; and, 3. the confutation of the received theories, or prevailing philosophies and doctrines. And this latter confutation has been such as it might be. viz. derived from signs, and the evidence of causes; for no other confutation could possibly

* But the greatest argument with most, is good success; which, in this case, has not been wanting, so as to encourage a farther prosecution of this design, upon as just foundations as the merchant traffics.

† See above, *Sect.* II.

be used by us, who differ from all others in principles and demonstrations*.

It would, therefore, be time to proceed to our rule and art of interpreting nature, did not something still lie in the way that requires to be removed. For as we proposed by an introductory set of Aphorisms to prepare the mind, as well to understand as to receive what is to follow; having now levelled and polished the mirror, it remains that we set it in a right position, or, as it were, with a benevolent aspect to the things we shall further propose. For in every new undertaking, not only the being strongly prepossessed with an inveterate opinion, but also a false notion or expectation of what is to follow, proves sufficient to give a prejudice. We must, therefore, next endeavour to establish a just and true opinion of the thing we intend, though this opinion be only temporary, and of use but till the thing itself is well understood.

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* See above, *Aph.* 35.

SECTION VII.

AN IDEA OF THE NEW METHOD OF INTERPRETING NATURE *.

116. WE postulate it of mankind, that they would not imagine we have any design to form a sect in philosophy, after the manner of the ancient Greeks, or some of the moderns. This is far from our view. Nor do we judge it material to the fortunes of mankind, what abstract opinions any one entertains of the nature and principles of things, no doubt but many of these may be borrowed from antiquity, and many new ones be introduced. Thus, for example, a great variety of hypotheses, though different among themselves, may well enough solve the phænomena of the heavenly bodies †.

* The idea given in this Section of the Author's method of interpreting nature, is rather a negative than a positive idea, and formed by excluding what it is not, rather than by directly shewing what it is, which will be the business of the Second Part to unfold But this Section was necessary to give some glimpse of the thing itself, and prepare the mind, by degrees, for the great light to be afterwards set up.

† Observe, that the most elegant and plausible solutions of phænomena, may be far removed from truth, and that various, contradictory, and yet equally probable solutions,

We are not solicitous about such useless things as depend upon opinion; but, on the contrary, resolve to try whether we can lay any firmer foundations of the human power and greatness, and enlarge the bounds thereof. And although we have, as we conceive, discovered certain particulars much more just, true, and advantageous than those at present in use, yet we lay down no one entire or general theory, for the time of this is not yet come, nor have we any hopes of living to finish the whole of our work, which is destined to receive a philosophy discovered by the genuine interpretation of nature, but hold it sufficient to carry ourselves soberly and usefully in moderate things; and, in the mean time, to sow the seeds of pure truth for posterity, and not be wanting in our assistance to the first beginning of great things.

117. And, as we are no founders of a sect: so are we no promisers of particular works. But, here it may be replied, that we, who so frequently make mention of works, and refer all things to them, should also give some ear-

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may be frequently given of the same appearance. So that to solve phænomena hypothetically, is a weak and childish thing in philosophy, or no better than the sport of fancy and imagination.

nests of them. But our design, as we have often said, is not to derive works from works, or experiments from experiments, like Empirics; but, like true interpreters of nature, from works and experiments, to derive causes and axioms; and from these causes and axioms, new works and experiments.

And, although any one of tolerable diligence and perspicuity, may find in our tables of invention; as also from the examples of particulars, produced in the second part of the present piece; and again, in our observations upon the history described in the third part; may, every where, find indications and designs of numerous noble works; yet, we ingenuously confess, that the natural history we have hitherto been able to procure, either from books, or our own enquiry, is not so copious, and so well verified, as alone to serve for, or even administer to, a genuine interpretation of nature *.

And therefore, if any one finds himself disposed, and fitted for going upon mechanical works; and has a sagacity at discovering them, from barely conversing with experiments; we

* This seems no way spoke out of modesty; but as the real truth; whence the principal thing, in order to a just and full interpretation of nature, is to procure an extensive and faithful history of nature and art.

leave him free, and recommend it to his industry to collect many particulars from our history and tables, as it were in passage, and apply them to works; after the manner of interest, for a time, till the principal may be received *. But, as ourselves endeavour after greater things; we here condemn all hasty and unseasonable stops; as being like the stopping of Atalanta; (a comparison we frequently use:) for we do not childishly affect golden fruit; but place the stress of the whole course, upon the victory of art over nature. And we are not so eager, as to reap moss for corn; or the tender blade for ears; but wait, with patience, the ripeness of the harvest†.

118. And some, without doubt, upon reading our history and tables of invention, will meet

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* It is no difficult matter, from the tables, larger observations, improvable axioms, and variable canons, that occur in the author's several pieces, to draw out models and patterns of considerable Works; or new practical arts, of importance; only, as philosophy is hitherto very imperfect; these models will scarce be perfect in the first essays; but may require many amendments, before they will answer. Whereas, in the author's manner of proceeding, it would be easy to form a just notion of the thing designed; and then directly put it in practice; without danger of miscarrying. But there are few that seem to apprehend the practicability hereof.

† See the Fable of *Atalanta* explained, in the *Sapientia Veterum*.

with experiments not well verified, or even absolutely false; and may thence, perhaps, be apt to suspect, that our inventions are built upon doubtful principles, and erroneous foundations. But this is nothing: for such slips must necessarily happen in the beginning. It is but as if here and there a letter should be misplaced, or mistaken, in a writing, or printed book; which does not, usually, much interrupt the reader: as such errors are easily corrected, from the sense of the place. In the same manner let men observe, that experiments may be falsly believed, and received in natural history; and yet soon after be expunged and rejected, when causes and axioms are discovered *. Though, it is true, that if there should be many, and frequent, and continued errors, in a natural and experimental history, they cannot be corrected by any

* It must be carefully observed, that even a large num- of errors, or falsities, in a natural history, designed for the foundation of philosophy, would not render it useless for the purpose; unless the number of errors should exceed the number of truths, it contained: for in that case, indeed, the causes, here mentioned, would be wrong assigned; and the axioms erroneous. But this cannot happen, where more truth than falsity prevails; and a few causes and axioms, discovered and formed, though but with tolerable exactness, may discover the depravity, or errors, of particular facts and experiments. This will appear plainer in the second part of the present work.

felicity of art or genius: and therefore, if in our natural history, which is collected, and examined, with so much diligence, so rigorous, and, as it were, with so religious a severity, there should sometimes happen any falsity, or mistake, with regard to particulars; what must be thought of the common natural history, which, in comparison of ours, is so negligent and remiss; or, what of the philosophy, and the sciences, built upon such quicksands *? Let no one, therefore, be concerned, if our history has its errors.

119. There will also occur, in our history and experiments, many things that appear at first sight; (1.) trifling and vulgar; (2.) filthy, sordid, and unpolite; (3.) too subtile, and merely speculative, or, as if it were useless: which may disgust, and alienate the minds of men, from considering them.

(1.) But, as for what our history may contain of vulgar: let men reflect, that they hitherto, usually, do little more than refer and accommodate the causes of such things as are rare, to such as are more common; without searching for the causes of those that frequently happen; but only receive them as granted and allowed.

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* The case requires no more than *Argumenta ad Hominem.*

Thus they seek not the causes of gravity, of the celestial motions, of heat, cold, light, hardness, softness, rarity, density, fluidity, consistence, animation, inanimation, similarity, dissimilarity, organization, &c. but discourse and judge of these, as of things evident, manifest and received; and thence of others, which occur less frequently, and familiarly.

But, as we are well apprized, that no judgment can be made of uncommon and remarkable things; much less that any new ones should be brought to light; unless the causes, and the causes of the causes of common things, are justly examined and discovered; we are necessarily obliged to receive the commonest things of all, into our history. And, indeed, we find nothing proves more prejudicial to philosophy, than that such things as are obvious, and often occur, should not arrest and detain the consideration of mankind; but are only received transiently, without enquiring into their causes: whence information is not so frequently wanted in things unknown; as attention in such as are known.

120. (2.) But for unpolite, or even sordid particulars*, which, as Pliny observes, require an apology for being mentioned; even these ought

* Such, for example, as observations and experiments upon putrefaction, the excrements of animals, &c.

to be received into a natural history, no less than the most rich and delicate; for natural history is not defiled by them, any more than the sun, by shining alike upon the palace and the privy. And we do not endeavour to build a capital, or erect a pyramid, to the glory of mankind; but to found a temple, in imitation of the world, and consecrate it to the human understanding: so that we must frame our model accordingly. For whatever is worthy of existence, is worthy of our knowledge, which is the image of existence: but ignoble things exist, as well as the noble. Nay, as some excrementitious matters, for example, musk, civet, &c. sometimes produce excellent odours; so sordid instances sometimes afford great light and information. But enough of this; as such a delicacy is perfectly childish and effeminate.

121. (3.) It deserves a much closer consideration, that many particulars in our natural history will, to an ordinary capacity, or even to any mind accustomed only to the present philosophy, appear like certain laboured, useless subtilties: and therefore, this objection deserves a primary regard. We have already observed, that at the beginning, and for a time, we seek experiments, that may afford light, not profit; in imitation of the Creator, who, as we must often repeat, produced nothing but light first day's work.

And to pretend that these subtile things are useless, seems like imagining, that light has no use; because it is not a solid, or tangible body. And, in reality, the knowledge of simple natures *, well examined and defined, is like light; and illuminates all the dark recesses of works: and though of no great use in itself, yet potentially includes and draws after it, whole troops and armies of works, and fountains of the noblest axioms. So the letters of the alphabet separately, and of themselves, are insignificative and useless; yet prove like first matter in the formation, or composition, of all speech and discourse. Even the seeds of things, though of such great efficacy, are useless, without the proper treatment; and the scattered rays of light itself, unless brought close together, do not impart their virtue.

But if any one is offended at speculative subtilties; what would he say to the schoolmen, who have given into subtilties without end? And yet these subtilties were about words, or at least vulgar notions, which comes to the same thing; and not about nature; and have proved also as useless in their consequence, as in their origin; being not of that kind, to be useless for the present, but infinitely useful in future; as those are whereof we now speak. And mankind may be

* Such as heat, cold, gravity, fluidity, &c.

certain of this, that all subtilty of dispute, and reasoning of the mind, if used only after axioms are discovered, comes too late, and out of season; and that the true, proper, or at least the principal time for subtilty, is in contemplating experience, and forming axioms from it*: for that other kind of subtilty catches at nature, without ever taking hold of her. And what is usually said of opportunity, or fortune, holds perfectly true, if transferred to nature; viz. that she has locks before, but none behind.

Lastly; with relation to this contempt of natural history, on account of its containing things that are vulgar, ignoble, subtile, or useless in their origins, we should here consider, as an oracle, the saying of the poor woman to the haughty prince, who rejected her petition, as a thing below his dignity to take notice of; then

* This alone is what properly deserves the name of theory in philosophy; that is, the viewing, or considering in the mind, how things are in nature; and thence forming axioms, or rules of practice, for producing works and effects. For want of attending to this fundamental point; men are apt to imagine, that philosophy is a light, airy thing, wherein every one may amuse himself, by raising hypotheses, and building systems, without the drudgery of consulting nature, and experience. But let it be well remembered, that the end of philosophy, is practice; or, that philosophy is no farther of use, than as it may be made operative.

cease to reign; for, it is certain, that whoever will not attend to matters of this kind, as if they were too minute or trifling, shall never obtain command or rule over nature*.

122. It may also seem a strange and shocking thing, that we should at once reject all the sciences, and all authors, at a stroke; without admitting any one of the ancients to assist, or defend us; but trust, as it were, to our own single strength.

We are well aware, that if we were any way disposed to act insincerely, it would not be difficult for us to attribute what we produce, either to the early ages †, (when, perhaps, the knowledge of nature, flourished more, though with

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* This whole *Aphorism* will, if duly considered, appear self-evident.

† This might have been an easy artifice for the author; considering how well versed he was in antiquity; and what a talent he had at explaining the mythology thereof: but this would, indeed, have been an imposition, or imposture; since no evident signs of any such inductive method, as that he proposes, are found in the ancients. But though the author does not use this artifice; it is certain he has used a particular art, in procuring credit and reputation to his inventions. But what kind of art this is, deserves, perhaps, like the art of government, to be in some measure concealed. Certainly the subtilty of the serpent, may be joined with the innocence of the dove. See hereafter, *Aph.* 128.

less pomp, than after it came into the flutes and trumpets of the Greeks,) or, even in certain particulars, to some of the Greeks themselves; and thence derive authority and honour to our inventions; after the manner of new raised persons, who fetch their nobility from some ancient line, by the favour of genealogies and descents. But relying wholly upon the evidence of things, we reject all stratagem and imposture *; and judge it of no greater moment to the business in hand, whether what shall be now discovered was known to the ancients, and by the vicissitude of things, and ages, is made to set and rise; than to be solicitous, whether America is the island Atlantis, mentioned by Plato, and known to the ancients; or whether it were first

* In another place, the author mentions, that if he were disposed to deal collusively with mankind; it would be no difficult matter to persuade them, that the ancient philosophers, long before the times of the Greeks, had a much deeper knowledge of nature; and thence artificially insinuate, that they prosecuted enquiries in the method himself proposes: whence he imagines he might have gained over to his side, all the admirers of antiquity; or those who rest upon authorities; which are a large number; and thus have found the less opposition in his promoting his grand design. But though himself appears to have conceived highly of the knowledge of the earliest ages of the world; as we find by his piece *De Sapientia Veterum*; yet he rejects this artifice as dishonest.

discovered by Columbus: for the discovery of things, is to be derived from the light of nature; and not from the darkness of Antiquity*.

But as to the general censure, of striking out all authorities and all the sciences, at once; certainly, whoever considers it rightly, will find this procedure more rational, and more modest, than to have done the thing but in part. For if errors had not been rooted in mens first notions; some things, justly discovered, might have rectified others: but as errors have been fundamental; and of such a kind, that men have rather neglected and passed things over, than formed a wrong or false judgment about them; 'tis no wonder if they have not obtained what they never had in view; not arrived at the end they never proposed; nor performed the course which they never entered †.

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* Notwithstanding the high opinion which the author entertained of antiquity, he tells us in another place, that, after having examined all the sects of philosophy among the Greeks, and other nations; he turned his eyes upon early antiquity; which he found as a remote tract, covered with clouds, and hid in obscurity.

† This sentiment is differently expressed in another place; thus—" As to the rejection of former doctrines, " this must be understood only of opinions; and not as de- " rogating from the genius, or labours, of the authors that " have gone before us. For the greater genius any man " has, and the more pains he takes, after having left the

And as to the point of insolence; it is true, that if one man should, by the steadiness of his hand, and the strength of his eye, pretend to draw a more perfect right line, or circle, than another, there would then be a competition in excellence; but for a man to assert, that by the ruler, or compass, he can draw a more perfect line, or circle than another, by the sole use of his hand and eye, is surely no great matter of ostentation. And this holds good, not only in our present, first attempt; but regards those also who shall endeavour to improve it after us: for our way of discovering the sciences, almost levels the capacities of men; and leaves little room for excellence; as it performs all things by sure rules and demonstrations: and therefore, these discoveries of ours, are, as we have often said, rather owing to felicity, than any great talent; and are rather the production of time, than of genius. For there is, doubtless, no less of accident in the thoughts, than in the works and actions of men.

123. And therefore we may say of ourselves, what was formerly said in the way of pleasantry; that it is impossible those who drink water,

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" light and history of nature, and the evidence of particu-
" lars; into the more dark and intricate dens and dungeons
" of fictions, and idols, he runs, and becomes involved."

should have the same sentiments with those that drink wine*. For all mankind, both ancients and moderns, have drank a crude liquor in the sciences, as a water that either flowed spontaneously from the understanding, or was drawn out of the well by the wheels of logic, whilst we drink a liquor, and offer it to others, prepared from an infinite number of grapes, ripe and seasonably gathered, in clusters, somewhat squeezed in the press; and, lastly, purged and clarified in the vessel†. Whence it is no wonder if we differ from others.

124. It will also, doubtless, be observed of us, that ourselves have not proposed the true and best end, or scope of the sciences, (the thing we censure in others) as the contemplation of truth

* The saying of Philocrates, when he differed from Demosthenes; viz. "Do not wonder, Athenians, that I differ from Demosthenes: for he drinks water, and I drink wine."

† The allegory is not difficult to interpret. The spontaneous water of the understanding is the natural unassisted human reason, in the ordinary way of exercising its talent. The water drawn by the wheels of logic, is chiefly such doctrine as we find in Aristotle, his commentators, and followers; but the wine of the Author is the knowledge gained from a large number of attentive observations made upon nature, and a variety of careful experiments, or a *Sylva* of matter, collected with choice and judgment, ruminated upon in the mind, and somewhat digested, and formed into Axioms and rules of practice.

is of greater dignity and sublimity than all utility and greatness of works, whilst the long and solicitous dwelling in matter, experience, and the uncertainty of particulars, which we recommend, fixes the mind to earth, or rather sinks it into an abyss of confusion and perturbation, at the same time driving and keeping it aloof from the serenity and tranquillity of a much diviner state, that of abstract wisdom.

We willingly allow the force of this argument, and above all things endeavour after what it intimates and requires. For we would place a true model of the world in the human understanding, such as the world is found to be, and not such as any one's reason might make it. And this cannot be done without first very carefully dissecting and anatomizing the world. But for those ridiculous and mock models of worlds, which the fancies of men have formed in philosophies, we reject them absolutely*; and therefore, let men well consider and understand the difference there is between the idols of the

* Such suppose as the categorical world of Aristotle, the world of Epicurus, the Platonical world, and, of later date, the Cartesian world, &c. almost every philosopher pretending to model the world in his own manner; or to shew, if he had been the creator, how wisely he would have made it. But to find out what the word is in itself, as the Author of Nature has made it, is the thing here proposed.

human mind, and the ideas of the divine mind, the former being no more than arbitrary abstractions, but the other the true signatures of the Creator upon the creatures, as impressed and limited in matter, by true and exact lines*. And therefore, truth and utility are here the very things required; and works should be more esteemed as they are pledges of truth, than as they are useful in life†.

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* *Viz.* Things themselves, with their differences, relations, dependencies, &c.

† Observe, that works, in the Author's sense, being derived from a knowledge of nature, are proofs that nature is understood, so far as regards the work effected; for works cannot be performed, without knowing how to perform them. And though this be a valuable fruit of knowledge, yet it is not the only one; but the contemplation of the truth, hereby confirmed to the mind, raises in it that veneration which is due to the Author of Nature, and wherein the perfection of the human intellect seems to consist. To this purpose, the Author adds, in another place: If any one, delighted with the love and veneration of contemplation, should think the frequent and honourable mention we made of works, sounds harsh and disagreeable, let him assure himself, that he acts contrary to his own desires; for, in nature, works are not only beneficial to life, but the token of truth. And as it is justly required in religion, that faith should be demonstrated by works, so it is congruous in natural philosophy, that knowledge also should be shewn and demonstrated by works; for truth is more manifest and confirmed by the indication of works, than by arguments, or even than by sense. So that the state and condition of men is im-

125. It may, perhaps, be likewise objected, that we are only doing what has been done before, that the ancients proceeded in the same way that we do, and therefore, that we shall probably, after all this struggle and striving, but at length come to some one or other of those philosophies which prevailed among the ancients; for that they, in the beginnings of their contemplations, procured a large stock of examples and particulars, digested them into registers, common-place books, and titles, and thence composed their philosophies and their arts, thus pronouncing upon full discovery, that they added examples occasionally, by way of confirmation, and as a help to instruction, but thought it needless and burthensome to publish their notes, memoirs, and common-place books of particulars, herein following the example of builders, who, after they have erected an edifice, take down the ladders and scaffolding, and remove them from sight.

It is true, one cannot easily believe that the ancients should have proceeded otherwise, but unless we forget what has been above delivered, this objection or scruple is easily removed. For,

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proved by the very same means that improve the mi-
We therefore judge, that what we have said of the d
and excellence of works, and the end in view, is no
to, but comes far short of the truth. See *Aph.* 129.

we confess, that the ancients had a form of enquiry and discovery, and their writings shew it, but this form was no other than flying from certain particular examples, with the assistance of common notions, (and, perhaps, some favourite part of the received opinions) to the most general conclusions or principles of the sciences, from the fixed and undisturbed truth whereof they drew out and proved inferior conclusions, by intermediate propositions, and built their arts of these materials; and if new particulars and examples arose, or were produced, to oppose their established doctrine, they either made them square, by subtile distinctions, or accommodated explanations of their own rules; or else, in a gross manner, struck them out by exceptions; at the same time laboriously and obstinately wresting, and fitting the more tractable particulars to their own principles. We must add, that neither their natural history, nor experience, was any way such as the case required; and that their method of bounding at once to their most general cunclusions, was the bane of philosophy*.

126. It may also be objected, that as we disallow a liberty of pronouncing, and laying down sure principles, till, by intermediate steps, we

* See above, *Sect.* I. and II. *passim*

shall have regularly come to the most universal conclusions; we patronize a suspension of the judgment, and bring all to a state of scepticism. The truth is, we intend and propose, not the art of doubting, in general; but the art of doubting, properly; for we do not detract from, but administer to the sense; and do not despise, but regulate the understanding. And it is better to know so much as is necessary, and yet not think ourselves to know all, than to think that we know all, and yet remain ignorant of that which is necessary*.

127. It may likewise be doubted, whether we speak only of perfecting natural philosophy, in our manner; or of the other sciences also, as logic, ethics, politics, &c. Our answer is, that what we here deliver regards them all. And as the common logic, which governs things by syllogism, belongs not only to the natural sciences, but to all; so our new logic, which proceeds by induction, comprehends every thing. For we design and draw up histories, and tables of invention, 1. for the passions of anger, fear, modesty, and the like; 2. for models of government and civil affairs; and, 3. for the mental actions of the memory, composition, division, judgment, &c. 4. for heat, cold, light, vegeta-

* See the *De Augment. Scientiar.*

tion, &c. But as our method of interpretation, after our history shall be once procured, and prepared, does not, like the common logic, regard only the motions and reasonings of the mind, but likewise the nature of things; so we conduct the mind in such a manner as that it may, in every respect, properly apply itself to the nature of things; and therefore shall deliver many different precepts, in the doctrine of interpretation, which may, in some measure, relate to the quality and condition of the subject enquired into, and the manner of invention*.

128. But no one, sure, can suspect, that we desire to destroy and demolish the philosophy, the arts, and the sciences, at present in use: for, on the contrary, we embrace their use, and willingly pay them all due honour and observ-

* A considerable part of this direction comes in the Second Part of this work. And that the Author extended his view, and fitted his new logic, to the purposes not only of physics, but universal philosophy, and the whole body of arts and sciences, appears from his *de Augmentis Scientiarum*, and *Sylva Sylvarum*, as well as from the present work, and the particular enquiries himself has begun; such as the History of Life and Death, the History of Winds, the History of Astronomy, the History of Philosophy, the History of Authors, Discourses of War, Government, Morality, Oeconomy, &c. So that the method of working by tables and induction seems excellently fitted for the due and commodious prosecution of all kinds of enquiries.

ance. And, indeed, we would no ways hinder them from being used in maintaining disputes, adorning discourses, and serving in the professory offices, and short methods of acting in civil life; or, again, from being received, like coin, by the common consent of mankind. For we openly declare, that the things we offer are not very conducive to these purposes, as they cannot be brought down to vulgar capacities, otherwise than by effects and works. And how sincerely we profess this affection and good-will towards the sciences already received, our former attempt for their advancement, may save us the trouble of repeating. But this we firmly and expressly aver, that by the methods now in use, no great progress can be made in the contemplative and doctrinal sciences; nor they possibly be employed for the enlarging and extending of works*.

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* This seems the proper place wherein to insert and preserve a few Aphorisms, belonging to the present subject, that were found scattered in other parts of the Author's works.

1. "But if any one shall think it needless in us to bestow so much pains and diligence in preparing the minds of men, or imagine that we do it in some measure to shew our parts and learning, and therefore had rather without all circumlocution. and preparatory discourse, be told the thing itself, directly, in few words: We answer, that we could wish, for the good of mankind, this wer-

129. It remains, that we say something to the excellency of the end in view; which, if said be-

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" the case; or that it were as easy to surmount the difficul-
" ties, and remove the impediments in our way, as it is for
" us to lay aside empty pride and ostentation. But we
" desire mankind should know, that we have had some ex-
" perience of the way, in this great solitude we are enter-
" ing, as the subject we have now in hand absolutely re-
" quires we should; and that we would by no means ex-
" pose or betray such a subject, through a want of skill to
" treat and deliver it. We must, therefore, assure them,
" from a thorough consideration and insight both of things,
" and the minds of men, that we find it almost harder to
" gain access to the mind, than to things; and that we find
" the labour and difficulty of delivering not much less than
" of discovering. So that we are here obliged to practice,
" what is almost a new thing in intellectual matters, com-
" plaisance, or courtship; and at once to bear the load,
" not only of our own thoughts, but those of other men.
" For the only way of subverting the idols of vanity is by
" approaching them obsequiously; and not by rushing in
" upon them with violence and fury.

2. " And this does not wholly happen from hence, that
" men are captivated with the admiration of authors; or
" swollen with their own conceits; or because, through
" custom, and prejudice, they will not be impartial: for,
" though a man would very gladly impose a just and even
" temper upon himself; and, as it were, forswear all pre-
" judice; yet even such a disposition of mind cannot be
" trusted. For no man has a command over his own under-
" standing, which depends not upon his will: Nor is the
" spirit of the philosophers, any more than the spirit of the
" prophets, subject to those it reigns in. It is not, there-

fore, might have seemed no more than a good wish; but now, when the grounds of hope are

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" fore, the equity, the sincerity, or the facility, of other " men; but our own conduct, discretion, and condescen- " sion, that must secure us in our undertaking, and render " it successful.

3. " And here, again, we lie under no small difficulty, " on account of our own natural temper and manners; for " it is an irrevocable decree with us, ever to retain our na- " tive candor and simplicity; and not attempt a passage to " truth under the conduct of vanity; but so to moderate " and behave ourselves, as not by any artifice, craft, cun- " ning, imposition, imposture, or any thing like imposture, " but barely by the ornament of order, and by diligently " engrafting new discoveries upon the soundest part of the " old ones; to work our way, and effect our design. So " far, therefore, from labouring this point too much, that " we rather judge we have bestowed less pains and dili- " gence in preparing men's minds, and conquering such " great difficulties, than the nature of the design requires.

4. " It is observable, that most men, in delivering or " concealing their knowledge, do not deal sincerely, or as " the nature of the thing demands And though the crime " may be less, yet the mischief is the same in those who are " of sound morals and approved candor; but want pru- " dence, or the art and method of delivering the things in " their just order. Yet this unfair, ungenerous, or unskil- " ful manner of delivering the sciences, is not greatly to be " complained of, as such writers have not, by their way of " delivering, broke the force of the things they deliver; " for a perverse way of teaching is justly preserved, where " only trifles are taught. But, as our design is not to de- " liver the fictions of our own fancy, the sport of words, a

laid, and unjust prejudices removed, it may, perhaps, have greater weight. If, indeed, we

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" mixture of philosophy and religion, nor certain popular " observations or considerable experiments, worked up into " fabulous theories; but real nature, with all her fruits " about her, we should think it a betraying of our trust, to " infect such a subject, either with an ambitious, an igno- " rant, or any other faulty manner of treating it. Our ut- " most study is, therefore, bent upon a just and proper me- " thod of delivering ourselves.

5. " Many will, doubtless, be inquisitive to know, what " this just and proper method is; and require it to be told " them naked and artless, without any preamble; that they " may exercise their own judgments upon it; and we wish, " indeed, matters were so well with them, that we might " gratify their request. But the truth is, the minds of men " have the ways and passages up to them, so thick beset, " and obstructed with such dark, deep-rooted, and invete- " rate idols, as in no wise to be soon cleared, laid level, " and polished, to receive the true and native images of " things. Whence we are obliged to use our utmost ad- " dress, to insinuate and slide into these dark and thick co- " verts. For as lunatics are only to be cured by art, and " proper applications; but are rather made worse by force, " opposition, and rough usage; the same course are we " obliged to take, and use a gentle method in the cure of " this universal madness. And here we, surely, have a " hard task, to deliver science so innocently, as to give no " occasion of error and offence; yet with such a native " and implanted force, as may procure credit, guard against " the injuries of time, and deliver knowledge down to pos- " terity; like a vigorous and lively plant, that may daily " grow and increase; whilst, at the same time, we single

had perfected the whole design, and did not desire others to share the labour with us, we would have dropped every thing of this kind, lest it should be taken for publishing our own merit; but as an edge must be given to the industry of others, and their minds be excited and raised, it is proper we should here admonish mankind of a few particulars.

And, first, the introduction of noble inventions seems to hold by far the most excellent place among all human actions. And this was the judgment of antiquity, which attributed divine honours to inventors, but conferred only heroical honours upon those who deserved well in civil affairs, such as the founders of empires, legislators, and deliverers of their country. And whoever rightly considers it, will find this a judicious custom in former ages, since the benefits of inventors may extend to all mankind, but civil benefits only to particular countries, or seats of men; and these civil benefits seldom descend to more than a few ages, whereas inventions are perpetuated through the course of time. Besides, a state is seldom amended in its civil affairs, without force and perturbation, whilst in-

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"out for ourselves, and, as it were, adopt a rightly disposed and legitimate race of readers. But whether we have done all this, must be left to the judgment of posterity."

ventions spread their advantage, without doing injury, or causing disturbance.

Discoveries also are like new creations, and imitations of the divine works. And, it is observable of Solomon, that he fixed not his glory in any of the privileges of royalty, or other excellencies whereof he was possessed, but in this single business of invention. It is the glory of God, says he, to conceal a thing; and the glory of the king to find it out.

Again, let any one consider what a difference there is betwixt the life led in any polite province of Europe, and in the savage and barbarous parts of the West-Indies, and he will find it so great that one man may deservedly seem a god to another, not only on account of greater helps and advantages, but also upon a comparison of the two conditions; and this difference is not owing to the soil, the air, or bodily constitution, but to arts.

Again, it may not be improper to observe the power, the efficacy, and the consequences of inventions, which appear no where plainer, than in those three particulars, unknown to the ancients, and whose origins, though modern, are obscure and inglorious, viz. the art of printing, gunpowder, and the compass, which have altered the state of the world, and given it a new face; 1. with regard to learning; 2. with regard

to war; and, 3. with regard to navigation. Whence numberless vicissitudes of things have ensued, insomuch that no empire, no sect, no celestial body, could seem to have a greater efficacy, and, as it were, influence over human affairs than these three mechanical inventions have had.

Again, it may not be amiss to distinguish three kinds, and, as it were, degrees of ambition in mankind; the first, that of such as desire to aggrandize their private power in their own country, which is the most vulgar and degenerate; the second, of such as endeavour to enlarge the power and empire of their country, in respect of others, which is more noble, though no less cupidinous; but if any one should strive to restore and enlarge the power and empire of mankind over the universe of things, this ambition, (if it deserves the name of ambition) is, without dispute, more solid and majestic than the others. But the empire of man over things is entirely founded in arts and sciences; for nature cannot otherwise be commanded, than by obeying her laws.

But if the utility of any particular invention can affect mankind so much as to make them think him more than human, who could, by any single benefit, oblige the whole species, how much more noble must it appear, to discover some one thing, by which all others may readily

be discovered * ? And yet to say the truth, as we are greatly obliged to light, because by its means we can see to read, find our way, exercise our arts, and distinguish one another; whilst the sight of the light itself is a more excellent and beautiful thing than these its various uses, so, without dispute, the contemplation of things, as they are in themselves, without superstition or

* Viz. A new machine, or logic, directing the mind to act upon all subjects with great advantage. This discovery the Author, in another place, compares to the discovery of the compass, thus. "As in former ages, when navigation "was directed barely by observing the stars, men could do "no more than coast it along the shores of the old world, "or cross some narrow seas, whilst the use of the compass "was required, before the great ocean could be traversed, "and the new world be discovered: In like manner, the "present discoveries in arts and sciences might be made by "instinct, experience observation, and contemplation, as "lying not very remote from sense; but, before the deep-"er and more remote parts of nature can be laid open, a "better and more perfect way of using and working with "the mind is necessarily required." He farther observes, that "the new world of knowledge differs from the new "world of America; the former being much better furnish-"ed with arts than the latter, so that the known arts of Eu-"rope are great things there; whereas, on the contrary, "the additions still required to the arts in use must be of a "higher kind, and so effectual as to bend, subdue, and "conquer nature, or affect her radically; for it almost "constantly happens, that the things easy to find prove but "of little service, whilst the roots of greatest virtue and "efficacy are deepest buried."

imposture, error or confusion, is itself of greater dignity than all the benefits of invention*.

If any one, in the last place, should object that the arts and sciences may be wrested, and turned to evil purposes, or sin, luxury, &c. this can have little weight, because it may be said of all the best things in the world, such as great capacity, courage, strength, beauty, riches, light itself, &c. Let but mankind recover their right over nature, which was given them by the Divine Being, let them be well provided of materials, and rectified reason and sound religion will direct the use†.

130. It is now time we should propose the art itself of interpreting nature, wherein, though we conceive that we have laid down highly useful and just precepts, yet we attribute no perfection, or absolute necessity, to this art of ours, as if

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* See above, *Aph.* 124.

† Perhaps it is not easy to form any considerable objection to the present design, besides those that have been already answered. However, if any remain, they have a right to be proposed, even though derived, as possibly all the above-mentioned are, from anticipation, or the common, imperfect, and hasty use of the rational faculty. Upon a retrospection, those that have produced appear chiefly personal, and are answered accordingly by arguments *ad hominem*, that do not directly affect the main of the question, only tend to molify and assuage men's minds, and allay the winds of prejudice and hasty opposition.

nothing could be done without it. For it is our opinion, that if men were possessed of a just history of nature and experience, were thoroughly versed therein, and could command themselves but in two particulars; the one, in laying aside received opinions and notions; the other, in withholding the assent, for a season, from general conclusions, they might, by their proper and native force of mind, without any other art, fall upon our form of interpretation, for the whole is no more than a genuine and natural work of the mind, when the obstacles to it are removed, though, doubtless, all will be made readier for use, and receive great strength, by our precepts.

Nor do we say that nothing can be added to these precepts of ours; on the contrary, we who do not highly esteem the mind in its own faculty, but chiefly so far as it is furnished and joined with things, ought to lay it down, that the art of invention may grow up with inventions themselves*.

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* The Author's Piece, entitled *Cogitata & Visa*, which was a rough draught of this first, or preparatory part of the *Novum Organum*, concludes thus. "The matter we have "in hand is not an opinion, but a work; and not designed "to lay the foundations of any sect or partial doctrine, but "to prove generally and extensively useful. Whence it "has required the greater care and consideration, not only "with regard to the perfecting of the thing itself, but also

" with regard to the manner of delivering and communi-
" cating it. For it is commonly found, that men have
" views to fame and ostentation, sometimes in concealing,
" and sometimes in uttering the knowledge they think they
" have acquired. And those also who have things but of
" little weight to offer, usually describe and put them off in
" half lights, the better to serve and humour their own va-
" nity. But for our undertaking, we judge it of such a na-
" ture, that it were highly unworthy to pollute it with any
" degree of ambition or affectation. And yet, unless we
" were greatly unskilled in the nature of men's minds, and
" of things, and desired to enter the road at once, without
" making the least trial thereof, it lies upon us to remem-
" ber, that inveterate errors can only be rooted out by art,
" and gentle treatment; and that, therefore, a certain pru-
" dence and compliance must be used, so far as may com-
" port with candor and simplicity, in order to prevent op-
" position before it is made. And, for this purpose, we are
" preparing a philosophical work, that may have a quiet
" and agreeable access to the senses of men. 'And this, we
" hope, will prove the easier, because we do not propose
" ourselves as leaders, but derive and scatter light from na-
" ture herself, so that there shall hereafter be no occasion
" for leaders. But time, in the interim, being on the
" wing, and the Author too much engaged in civil affairs,
" especially considering the uncertainties of life, he would
" willingly hasten to secure some part of his design from
" contingencies; and after much close thought, and a deli-
" berate consideration, he determined, that, to prevent so
" useful a thing from disaster, the best course was to pro-
" pose and lay down certain tables of invention, or forms
" of genuine enquiry, that is, the digested matter of parti-
" culars, designed for the work of the understanding, and
" this in some determinate subjects, by way of exam
" a palpable model of the whole. Nor could h

"any thing better for setting the true manner of proce-
"dure, and the errors of the way, in a clear light; or for
"evidently shewing, that the things delivered are solid,
"and not the sport of words! and, again, for distinctly
"pointing out what they should avoid who either distrust
"the design, or conceive too highly of it. And hence,
"though we should not ourselves compleat the undertak-
"ing, yet men of a solid and sublime genius, being thus
"admonished by what we have offered, may, without any
"greater assistance, expect the rest from themselves, and
"finish it. For as to the matter in hand, we are almost of
"his opinion, who said, This is enough for the wise; and
"for the unwise, more would not be serviceable. But as
"it would have appeared too abrupt to have begun with
"the tables themselves, we thought proper to introduce
"them by this preparatory discourse.

PART II.

SECTION I.

PARTICULAR APHORISMS FOR INTERPRETING NATURE; OR, THE MEANS OF ENLARGING THE HUMAN POWER AND KNOWLEDGE, BY THE DISCOVERY OF FORMS.

APHORISM I.

1. IT is the office and end of the human power to generate, or superinduce, a new nature or natures upon a body assigned; and, 2. the office and end of the human knowledge, to discover the form of a nature assigned; that is, its real difference, naturizing nature, law, or the fountain from whence it flows, which are terms we use, in order to give some tolerable notion of our meaning*. And, subservient to these two

* For a fuller notion of forms see below, *Aph.* 2, 17, 20. and *Sect.* II. *Aph.* 23, 27, &c. But, to render this Aphorism more clear and intelligible, we may turn it thus. "Upon a given basis of matter, to form or introduce a new "nature, in all possible cases, is the use and exercise of our

primary works, there are two other secondary ones, of inferior consideration, thus, 1. to the former belongs the transformation of concretes, from one thing into another, through all possible variety; and, 2. to the latter, the discovery of the latent process in every generation and motion, as it is continued from the manifest efficient, and the manifest matter, up to the giving of the form; and, in like manner, there belongs to it the discovery of the concealed structure of quiescent bodies, or bodies that are not in motion*.

2. How inadequate and unsuccessful that human knowledge is, which we have at present in

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" powers, and to discover the causes of the effects in all " subjects, is the use and exercise of our knowledge, which " are two coincident intentions, and in effect the same. " For what, in speculation, appears to be the cause, is, in " practice, the means of action, and directs us in the per- " forming the thing. Thus, for example, upon finding that " the specific and determinate virtues, or tastes and odours " of certain aromatic plants, reside in their essential oils, " we are hence directed to obtain these oils, in order to " procure the peculiar virtues, tastes, and odours of such " plants. And thus the case holds universally, as will " more fully appear hereafter." See below, *Aph.* 3, 4, 11, 12, &c.

* The present set of Aphorisms will require a considerable degree of attention, and should be read in the manner of mathematical demonstrations.

use, may appear from the things commonly asserted*. It is certain, that true knowledge is the knowledge of causes. Now we may properly make four kinds of causes, viz. 1. the matter; 2. the form; 3. the efficient; and, 4. the end. But the latter, or final cause, is so far from being serviceable, that it corrupts the sciences, unless it be restrained to human actions. The discovery of forms is held desperate, and the efficient and material causes, in the manner they are at present sought after and admitted, (viz. the remote efficient, and the remote material causes, without the knowledge of the latent process up to the form) are trifling and superficial things, that scarce at all contribute to real and effective knowledge. It is true, we above noted and corrected the error of the mind, in attributing the essences of things to forms†; but although in nature nothing really exists besides individual bodies, that perform individual actions, by a law; yet in doctrine this law itself, the enquiry into it, with the discovery and explanation thereof, is the foundation as well of knowledge, as of works; and it is this law, and its parts, that we

* Which are seldom found, upon farther enquiry, to be derived from their causes, so that they frequently fail when used as rules of practice. See the First Part. *passim*.

† See above, *Aph.* 51.

understand by the name of forms *, especially as the term already prevails, and is grown familiar †.

3. He who knows the cause of any nature, as, for instance, that of heat, or whiteness, in certain subjects only, has an imperfect knowledge; he who can produce an effect upon certain matters only, among those susceptible thereof, has, in like manner, an imperfect power; and he who knows only the efficient and material causes ‡. which are unstable, and, in some cases no more than vehicles, or causes that carry the form, may arrive at new inventions in a subject somewhat similar and prepared, though he cannot remove the boundaries of things that are deeper fixed; but he who understands forms, will perceive the unity § of nature in the most dissimilar

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* By the word forms, therefore, we are to understand a full and clear knowledge of the law, procedure, or means of nature, in producing effects. This notion will, however, be farther improved and explained hereafter. See below, *Aph.* 17, 20.

† The Author every where endeavours, as much as possible, to retain the ancient terms, though he conveys new meanings under them, as judging it best to innovate, like time, by degrees.

‡ See *Aph.* 2. of this Part.

§ *Viz.* The uniformity, or rather the identity, or sameness, of nature; for by the supposition, forms are the laws of nature; according to which she constantly acts; that is

cases; and may therefore discover and produce such things as have not hitherto appeared; or such as neither the vicissitudes of nature, nor the industry of experimenting, nor chance itself, could ever have brought into being: nor would they otherwise have entered the thoughts of men*. So that justness of theory, or contemplation, and freedom of practice, or operation, depend upon the discovery of forms.

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ever in one and the same manner; so that a knowledge of forms is a knowledge of the unity, identity, or what may be called the manner of nature.

* In another place, the author has broke this *Aphorism* into Parts; which may render it more intelligible; viz.

1. " He who understands the cause of any nature in " certain subjects only, has but an imperfect knowledge; " as he who can produce an effect only in one certain mat- " ter, of all those susceptible thereof, has but an imper- " fect power.

2. " He who understands efficient and material causes, " is thence instructed how to compound, divide, transfer, " or produce, and even proceed to new discoveries, in sub- " jects of a somewhat similar and disposed matter; but " cannot by this means alter the deep fixed limits of things.

3. " He who understands the causes of any nature but " in certain subjects, knows only the efficient, or material " causes, which are unstable things; and no more than " vehicles of causes, wherein the form resides; but he who " understands the uniformity of nature, in very different " kinds of subjects, has a knowledge of the forms of " things.

4. Although the human power, and human knowledge, are nearly allied, and, in a manner the same; yet by reason of the pernicious and inveterate custom of dwelling in abstract notions, it is abundantly the safest way to begin and build up the sciences, from those foundations which are laid in order to practice, so as to let this mark out, and determine the theory. We shall, therefore, here examine what kind of rule, directions or leading, a man would principally wish for, in order to superinduce an assigned nature upon a given body.

Thus if any one should desire to superinduce upon silver the yellow colour of gold, and to increase its specific gravity, or to superinduce

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4. "He who understands forms, will discover and produce such things as are hitherto unknown, and unproducted; and such as neither the revolutions and changes of nature, nor experience, would ever have manifested; nor the thoughts of men ever otherwise have conceived.

5. "The way and perfection of truth and power is the same; viz. the discovery of forms: upon which ensues both a just theory, and an unlimited practice. And hence it appears, that the perfection of human knowledge, both speculative and practical, is the knowledge of forms. For to contemplate the process of nature in her works, is a just theory, that leads to a pefect practice." No wonder, therefore, if the discovery of forms be the sole business of this Second Part of the *Novum Organum*.

transparency upon an opaque stone; malleability upon glass; vegetation upon a body not of the vegetable kind, &c. he would, doubtless, desire to be shewn, (1.) some way that should not frustrate his labour, or fail him upon the trial. (2.) He would desire such a method as should not tie him down, or confine him to the use of certain determinate means, and particular ways of working; because he might, perhaps, be unprovided herein; or not have the power and convenience of procuring the necessary helps: And if there were other methods, within his power, besides that delivered in the rule, for superinducing such a nature, that he might not be excluded their use, through the limitation, or narrowness of his rule; and so not receive the benefit of those methods. (3.) He would wish to be shewn something less difficult than the operation he enquires after; and such as might approach nearer to practice.

The precept, therefore, for a true and perfect practical rule, is, that the rule be sure, unrestrained to particular means or expedients; and dispose or lead directly to action; and this is the same thing with the discovery of a real form. For, the form of any nature, is such, that where it is, the given nature must infallibly be: The form, therefore, is perpetually present, when that nature is present: ascertains it universally

and accompanies it every where. Again, this form is such, that when removed, the given nature infallibly vanishes: Therefore the form is perpetually wanting, when that nature is wanting; and thus confirms its presence, or absence; and goes and comes with that nature alone. Lastly, a true form*, is such as can deduce a given nature from some essential property†, which resides in many things; and is more intimately known, or linked to nature, than the form itself. The precept, therefore, for a true and perfect theoretical axiom, to find another nature, that may be convertible with the nature assigned; yet limit the more common nature, like a true genus‡. These two precepts, the former whereof is practical, and the latter spe-

* Viz. A knowledge of nature's means, in producing any effect. See *Aph.* 3. of this Part.

† To find this property, therefore, readily disposes and leads to practice, by singling out one particular property, whereon the rest depend; instead of pursuing a great many. Thus, it should seem, that if any matter could be made as ponderous as gold, it would become gold; or if any matter could be made as hard and resplendent as the diamond, it would become diamond, &c.

‡ So, for example, by enquiring into the form of heat, a particular shuddering motion among the small parts of bodies, seems the convertible nature, or form, that, like a true genus, limits the more common nature of heat. See below, *Aph.* 15, 16, 17, 18, &c. but particularly, *Aph* 20.

culative, are one and the same thing *; and so what proves most useful in practice, is also perfectly just in theory †.

5. But the rule, or axiom, for the transmutation of bodies ‡, is of two kinds. The first, regards a body, as a certain collection or combination of simple natures ‖. Thus, for example, in gold, there meet together yellowness, a determinate gravity, malleability to a certain degree, fixedness in the fire, a particular manner of flowing in the fire, a determinate way of solution, &c. which are the simple natures in gold. And, therefore, this kind of axiom deduces the thing from the forms of simple natures. For he who understands forms, and the manner of superinducing this yellowness, gravity, ductility, fixedness, faculty of fusion, solution, &c. with their particular degrees, and proportions, will consider and provide how to join them together in some body; so that a transmutation into gold shall follow: and this kind of opera-

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* See Part I. *Aph.* 3.

† The meaning is, that to gain the best practical rules, we must discover the forms of things; that forms are rules; and theory and practice the same thing. The following Aphorisms will add more light hereto. See in particular, *Aph.* 9.

‡ See *Aph* 1. of this Part.

‖ Or what we commonly call properties.

tion regards the principal action. For the way is the same of producing any one simple nature, as many: only man is more confined and restrained in working where many are required; because of the difficulty of uniting a variety of natures together, which do not easily meet, except in the common and beaten roads of nature *. And yet this method of working, which regards simple natures, though in a concrete body, may proceed upon such principles as are constant, eternal and universal in nature; and afford such broad ways to the human power, as the mind, in the present state of things, can scarce conceive or represent to itself †.

But the second kind of axiom, which depends upon discovering the latent process ‡, does not proceed by simple natures; but by concrete bodies, such as they are found in the ordinary course of nature: For example, when enquiry is made from what origin, by what means, and

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* Viz. As they are united by nature herself; for example, in gold, quicksilver, &c.

† There are several attempts of this kind in the *Sylva Sylvarum*. See particularly, the articles gold, transmutations, &c. But a more perfect history of nature and art must be procured, before any successful method of this kind can be formed.

‡ Viz. The several continued steps, or whose procedure of nature, in producing effects. See below, *Aph.* 6.

what procedure, gold, or any other metal, or stone, is generated, from its first fluid matter, or rudiments, up to a perfect mineral: Or, again, by what process plants are generated, from the first concretions of their juices in the earth, or from the seed, to a formed plant; together with the whole succession of motion, and the various and continued endeavours of nature. Understand the same of regularly explaining the production of animals, from the first act of generation; and so of other bodies*.

And this enquiry does not only regard the generation of bodies: but likewise other motions and works of nature: for example, when enquiry is made into the whole series and continued actions of nutrition, from the first receiving of the aliment, to a perfect assimilation; or, after the same manner, into the voluntary motion of animals, from the first impression of the imagination, and the continued efforts of the spirit, down to the bending and moving of the limbs; or, again, in explaining the motion of the tongue, lips, and other organs, up to the formation of articulate sounds. For these things also have regard to concrete natures, or natures associate and organical; and belong, as it were,

* Let an eye be had all along to the first Aphorism of this section; where a foundation of the whole is laid.

to the particular and especial customs of nature; and not to the fundamental and common laws which constitute forms. It must indeed be allowed, that this method seems more facile, quick and promising, than the primary method, above mentioned *.

But the effective part, which answers to this speculative one, in like manner extends, and advances its operation, from those things which are commonly found in nature, to certain others that lie near, or not very remote: though the higher and radical operations upon nature require the former primary axioms. And where mankind has no power of operating, but only of contemplating, as in the celestial bodies, which we cannot operate upon, change or transform; yet the enquiry of the fact, or truth of the thing, belongs, no less than the knowledge of causes, and relations, to the primary, and universal axioms of simple natures †: suppose, for example, the enquiry about the nature of spontaneous rotation, attraction, and many other natures; which are more common and familiar to us than the celestial bodies themselves. And let no one expect to determine the question, whether the diurnal motion belongs to the hea-

* See above, §. 7. and again, *Aph.* 1.

† See above, §. 7.

vens or the earth, unless he first understand the nature of sponataneous rotation *.

6. The latent process we speak of †, is a thing that cannot easily enter the mind, so beset as it is at present: for we do not here mean certain visible measures, or signs, or steps of procedure in bodies; but a perfect continued process, the greatest part whereof escapes the sense.

Thus, for example, in every generation and transformation of bodies, it comes to be enquired what is lost, or flies off; what stays behind; what is added; what dilated; what contracted; what united; what separated; what continued; what cut off; what impells; what obstructs; what prevails; what yields, &c.

Nor are these things only to be sought in the generation, or transformation, of bodies; but after the same manner, it comes to be enquired in all other alterations and motions; what precedes; what succeeds; what is quick; what slow; what gives motion, what governs it; and the like. But all these things remain unknown, and untouched in the sciences, which are, at present, formed in a very gross, and perfectly

* Because the more simple, common, and obvious natures must be understood, before we can hope to understand such as are compounded, remote, or abstruse.

† See Part II. *Aph.* 1.

inadequate manner. For as every natural action is performed by the smallest particles, or at least by particles so small as to escape the senses: let no man expect to govern nature, or turn her course, till he has, in a proper manner, become acquainted with these small particles.

7. Again; the enquiry, and discovery, of the concealed structure in bodies, is as much a new thing, as the discovery of the latent process and form: for men have hitherto trod only in the outer courts of nature; and are not prepared to enter within. But no one can superinduce a new nature upon a given body; or successfully and appositely change it into another body; unless he has first a competent knowledge of the body to be altered, or transformed; as without it he will fall upon frivolous methods, or at least such as are difficult, perverse and unsuitable to the nature of the body whereon he operates: and therefore in this respect also, a way must be necessarily opened and prepared.

Labour is properly and advantageously bestowed upon the anatomy of organical bodies; such as those of men and brutes: as it seems a thing of subtilty, and a good scrutiny of nature. But this kind of anatomy is a work of the eye, subject to sense, and takes place only in organical bodies; so that it is an obvious and facile thing, compared with the real anatomy of the

latent structure in bodies accounted similar; especially in specificate things and their parts; as iron, and stone; the similar parts of plants and animals, as the root, leaf, flower, flesh, blood, bone, &c. And in this particular, human industry has not been entirely wanting; as appears from the separations of supposed similar bodies by distillations, and other methods of solution, in order to shew the dissimilarity of the compound, by separating and collecting its different homogeneous parts together: which is a thing of use, and makes to our present purpose: though it is often fallacious; because many natures are attributed to separation, as if they pre-existed in the compound; whilst they are really given, and originally superinduced by the fire, heat, or other method of resolving them. And this also is but a small part of the business of finding the true structure of a compound; as this structure is a thing of very great delicacy and subtilty; and rather confounded than discovered, and brought to light, by the operations of the fire*.

Bodies, therefore, are to be separated, and resolved, not by fire, but by reason, and genuine

* The fire is a very improper analyser in many cases; especially where the subject is capable of being scorched, or rendered empyreumatic; which quite perverts or alters its nature; as we see in burnt sugar, &c.

induction; with the assistance of experiments; and again, by comparing them with other bodies, and reducing them to simple natures, and their forms, which meet and are combined in the compound; for we must go over from Vulcan to Minerva, if we would bring to light the real textures and structures of bodies; wherein all the secret and specific properties and virtues of things depend; and from whence the rule of every powerful alteration, and transformation, is to be derived.

Thus, for example, we must enquire, what the spirit in every body is; and what the tangible substance; whether this spirit be copious and turgid, or hungry and small in quantity; whether it be thin or gross; airy or fiery; brisk or sluggish; weak or strong; in progress or recess; interrupted or continued; agreeing or disagreeing with the things external and circumjacent, &c. And in like manner we are to enquire about the tangible substance (which admits as many differences as the spirit;) what its coats, its grain, and fibres, its kinds of texture. Again, under the same enquiry comes the distribution of the spirit through the corporeal mass; with its pores, passages, veins, cells, and the rudiments, or first lineaments of the organical body. In which cases also, and consequently in the Investigation of every concealed structure, a

a true and clear light is afforded, by our primary Axioms, sufficient to dispel all darkness and useless subtilty*.

8. Nor will this bring us to the hypothesis of atoms, which erroneously presupposes vacuity, and a permanent state of matter, but to real particles, such as they are found. Nor need any one dread this subtilty, as inexplicable*; for, on the contrary, the more the enquiry tends to simple natures, the plainer and clearer will every thing become, the business being thus brought from multiplicity to simplicity, from incommensurables to commensurables, from surds to computables, and from things finite and vague, to such as are definite and certain, as in the case of the letters of the alphabet, and the notes of

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* See Part II. *Aph.* 1, 5, and 7.

† This caution appears to be seasonably interposed; for, doubtless, many readers, who have not been used to abstruse speculations, or mathematical reasoning, will be at a loss to perceive what the Author drives at, or be apt to imagine the whole an intricate subtilty, not worth the trouble of understanding. Those who think in this manner, may please to pass over, for a time, the first ten Aphorisms of this Second Part, and begin with the eleventh; for the practical tables, and actual method of investigating the forms of things, (where all is performed by examples and sensible representations) will prepare the mind, and facilitate the understanding of these more abstruse Aphorisms, if read after some tolerable notion of the business in hand, and the method of conducting it, is procured.

music*. And it is then that a natural enquiry proceeds justly, when physical considerations terminate in such as are mathematical†. And again, let no one be frighted at multitude or fractions, for in things performed by numbers, it is as easy to set down, or think of a thousand, as of one, or of the thousandth part of an unite, as of an unite itself.

9. From the two kinds of Axioms above laid down, arises a just division of philosophy and the sciences, taking the received terms (which come nearest in expressing the thing) agreeably to our own meaning, viz. so that the enquiry of forms, which from the reason of the thing itself, and their own law, are eternal and immutable, may make metaphysics; and the enquiry into the efficient, the matter, the concealed process, and latent structure, may constitute physics, as

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* For as all the variety of sounds and words are made out of twenty-four letters, and all the variety of tunes out of eight notes, so a few simple natures, or primary properties, (such as fluidity and firmness, volatility and fixedness, &c.) appear to compose all that variety which we find in bodies.

† For all the motions, powers, forces, operations, energies, and quantities of bodies, must be computed, measured, and determined, before natural philosophy can be perfected. But let not the calculation be rashly applied, before the facts are discovered and ascertained, for mathematics is not to constitute, but only to limit physics.

these several particulars regard the common and ordinary course, and not the fundamental and eternal laws of nature. And let each have its corresponding branch of practice, and méchanics be made subservient to physics, and magic (taking that word in its genuine sense) to metaphysics, on account of the wide passage which magic affords into, and the great command it has over nature *. And having thus established the scope and end of our doctrine, we proceed, in a regular manner, to precepts †.

10. The indications for the interpretation of nature include two general parts; the first reates to the raising of Axioms from experience, and the second to the deducing or deriving of new experiments from Axioms‡. The first is

* This division appears extremely just and useful, but has not, perhaps, been any way considered and regarded as it deserves, on account of the imperfect state of philosophy, for as philosophy improves, this division must, almost of necessity, take place.

† The nine preceding Aphorisms are a kind of close-wrought, axiomatical chain of doctrine, that, when rightly understood, will appear deep, sagacious, and drawn from nature, so as to lay a firm, just, and adequate foundation for the intended new logic, or method of investigating the forms of things.

‡ This deriving of new experiments from Axioms, is a part of the present work that was not published. See below, *Aph.* 21.

divided into three kinds of administrations or helps, viz. the helps, 1. for the sense; 2. for the memory; and, 3. for the reason.

(1.) Therefore, a just and adequate natural and experimental history is to be procured, as the foundation of the whole thing; for we are not to fancy, or imagine, but to discover what are the works and laws of nature.

(2.) But natural and experimental history is so copious and diffusive a thing, as to confound and distract the understanding, unless such history be digested and ranged in proper order; therefore tables, and subservient chains of instances, are to be formed and digested in such a manner, that the understanding may commodiously work upon them.

(3.) And though this were done, yet the understanding left to itself, and its own spontaneous motion, is unequal to the work, and unfit to enter upon the raising of Axioms, unless it be first regulated, strengthened, and guarded; therefore, in the third place, genuine and real induction must be used as the key of interpretation. But we are to begin at the end, and proceed backwards to the rest*.

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* That is, we are to begin with induction, and proceed backwards to the forming of a natural and experimental history, and then to the forming of Axioms, &c.

The enquiry of forms* proceeds in this manner. First, all the known instances agreeing in the same nature, though in the most dissimilar subjects, are to be brought together, and placed before the understanding. And this collection is to be made historically, without any overhasty indulgence of speculation, or any great subtilty for the present. We will illustrate the thing by an example in the enquiry into the form of heat.

* Whereon the advancement and perfection of philosophy, the sciences, and all practical arts depend, as has been shewn above, *Aph.* 1—7.

THE TRUE METHOD OF DISCOVERING FORMS, ILLUSTRATED BY AN EXAMPLE IN THE FORM OF HEAT.

TABLE I.

Instances agreeing in the Nature of Heat *.

(1.) THE sun's rays, especially in summer, and at noon-day.

(2.) The reflex and collected rays of the sun, as betwixt mountains and walls, but particularly in burning-glasses.

(3.) Fiery meteors.

(4.) Burning lightning.

(5.) Eructations of flame from the caverns of mountains, &c.

(6.) Flame of all kinds.

(7.) Ignited solids.

(8.) Natural hot springs.

(9.) Heated fluids.

(10.) Hot vapours and fumes, and the air itself, which conceives a violent and raging heat, when pent up, as in reverberatory furnaces.

* Viz. A collection of the particulars wherein heat is found, so that the following particulars agree in having the nature of heat common to them all.

(11.) Certain clear, sultry seasons, from the constitution of the air, without regard to the time of year.

(12.) Subterraneous air, confined in certain vaults or caves, especially in the winter.

(13.) All shaggy matters, as wool, the furs and plumage of animals, have some degreee of warmth.

(14.) All bodies, as well solid as fluid, dense as rare, even the air itself, exposed to the fire for a season, become hot.

(15.) The sparks caused by a strong percussion betwixt the flint and steel.

(16.) All bodies upon a strong attrition, as stone, wood, cloth, &c. whence the axletrees and wheels of carriages sometimes take fire; and it has been a practice to procure fire by attrition in the West-Indies*.

(17.) Green and moist plants, laid up and pressed close together, as roses, pease in carts, &c. so likewise hay stacked before it is dry, often takes fire*.

(18.) Quick-lime, slaked with water.

(19.) Iron, when first dissolved with acid spirits, though contained in a glass, without

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* Viz. By rubbing two sticks together in a particular manner.

† See Boerhaave's Chemistry, Process 88, on the Putrefaction of Vegetables. See also the Paper of Dr. Cox, upon the same subject in the Philosophical Transactions.

any assistance of the fire; and, in like manner, tin, &c. though not so intensely.

(20.) Animals, especially their inward parts; though in insects, by reason of the smallness of their bodies, no heat is discoverable to the touch.

(21.) Horse-dung, and the like recent excrements of animals.

(22.) Oil of vitriol, aqua fortis, &c. have the effects of heat in burning linen, &c.

(23.) The essential oil of origanum, and the like, have the effects of heat in burning the teeth*.

(24.) Well rectified spirit of wine has the effect of heat, so as to blanch and harden the white of an egg put into it, almost like boiling water; it also hardens or scorches, as it were, bread that is suffered to lie therein.

(25.) Spices, and spicy herbs, such as dragons, old cresses, &c. though not hot to the hand, either whole nor in powder, yet when chewed a little, are found hot, or burning, to the tongue and palate.

(26.) Strong vinegar, and all acids, cause a pain not greatly differing from that produced by heat, when such acids are applied to any part of

* All the essential aromatic oils seem heating and inflaming to the body, particularly the oils of cinnamon, cloves, cortex winteranus, &c.

the body that is not defended by a scarf-skin, as the eye or tongue, for example, that are naked, or any other part that is wounded and laid bare.

(27.) Even severe and intense cold produces a sensation like that of burning*.

(28.) Instances forgot or omitted†.

And this table we call the presenting, or affirmative table‡.

12. In the second place, those instances are to be brought before the understanding, which have not the nature assigned, because the form, as we said, ought no less to be wanting, where the given nature is wanting, than to be present, where that is present; but as it would be endless to pursue these instances throughout, negatives are to be subjoined to the affirmatives, and the want of the given nature to be considered only in such subjects as are nearest related to those wherein it resides and appears. And this Table we call the Table of Declination, or of Absence in Approach§.

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* —— *Boreæ penetrabile frigus adurit.* Thus the handling of snow or ice will make the fingers glow.

† Observe, that this table is here only to serve as an example, and not as an actual enquiry prosecuted to its due length.

‡ Because it exhibits the facts, or shews in what subjects the nature enquired after resides.

§ Because it exhibits those particulars, wherein, through nearness, or apparent similarity, the given nature might be

TABLE II.

INSTANCES OF APPROXIMATION, YET WANTING THE NATURE OF HEAT.

The first Negative, or Subjunctive Instance, to the first Affirmative.

(1.) THE rays of the moon, stars, and comets, are not found hot to the touch; and the sharpest colds are observed in the full of the moon. But when the sun is in conjunction with the larger fixed stars, or approaches near them, such stars are thought to augment the heat; as when, for example, the sun is in Leo during the dog-days*.

A second Negative Instance, to the second Affirmative.

(2.) The rays of the sun, heat not in that called the middle region of the air; and the reason commonly assigned with some probability for it is,

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expected, and is yet found to be wanting. Thus, as the rays of the sun are found hot, the mind is apt to infer the same, in a less degree, of the rays of the moon; but the rays of the moon have no sensible heat, though they are the very rays of the sun by reflection.

* It might be proper, in practice, or when any particular enquiry is gone upon, to write these tables in opposite columns, on the same paper, which would render the whole more commodious and ready for use.

because the body of the sun that emits the rays, never sufficiently approaches either that region, or the earth, which immediately reflects them; and this appears from the tops of mountains, unless extremely high, where the snow continually lies. But, on the contrary, it is observed by some, that no snow is lodged on the tops of the pike of Teneriff, and the Andes, or high mountains of Peru, but only upon the lower declivities. Besides, the air on the tops of these mountains is not found cold, but only thin and sharp, so as on those of Peru, to prick and vellicate the eyes, and mouth of the stomach, and cause a vomiting by their acrimony. And, it is observed by the ancients, that the air was so thin on the top of Mount Olympus, as to make it necessary for such as went up, to carry along with them spunges dipt in vinegar and water, and every now and then apply them to the mouth and nose; because the air, through the great degree of its rarifaction, was not there sufficient for respiration*. And on the top of this mountain there was said to be so great a serenity and tranquillity, from rain, snow, and wind, that the letters drawn by the fingers of those who sacrificed there, upon the altar of Jupiter, would remain in the ashes of the sacrifice, unaltered, till the year ensuing. And

* Will this expedient, in any respect, supply the want of air for respiration?

at present, the persons that go up to the top of Teneriff, travel by night, not by day; and soon after sun-rising are advised and pressed by their guides to make haste down, for fear of being rendered breathless by the thinness of the air*.

A third Negative, to the second Affirmative.

(3.) The reflection of the sun's rays, in the parts near the polar circles, is found exceeding weak and faint in point of heat; so that the Hollanders, who wintered in Nova Zembla, expecting, by the beginning of July, their ship to be freed from the mass of ice wherein she was froze, found themselves disappointed, and were obliged to commit themselves to their long-boat. Therefore, the direct rays of the sun seem to have little power, even upon a flat surface; and so have the reflex rays also, unless multiplied and united, as they are when the sun becomes more perpendicular; because the rays then strike in acuter angles, and so come nearer to one another; whilst in great obliquities of the sun, the angles are very obtuse, and consequently the rays at a greater distance one from another. It must, however, be observed, that there may be many effects of the sun's rays, and such as participate of the nature of heat, which are

* It is, with certainty, found by the barometer, and otherwise, that the air grows rarer and rarer, in proportion to the height ascended upon hills.

not proportioned to our sense of touch, so that with respect to us, they produce no warmth, though with respect to some other bodies, they may have the effect of heat*.

A fourth, to the second.

(4.) Let this experiment be made: Take a glass, fashioned in a contrary manner to that of a common burning-glass, and place it between the hand and rays of the sun, in order to observe whether it diminishes the sun's heat, as a burning-glass increases it†. For, it is manifest, with regard to the optic rays, that according as a glass is made of a different thickness, with respect to the middle and the sides, so the objects seen through it appear larger, or more diminished; the effect should, therefore, be tried in heat.

A fifth, to the second.

(5.) Let a careful experiment be made, to shew whether, by the most powerful and best contrived burning-glass, the rays of the moon may be collected so as to afford any, the most minute degree of warmth. But if this warmth should prove too subtile and weak to be perceived by the touch, recourse must be had to ther-

* See Mr. Boyle's History of Cold. Abridgm. Vol. I. p. 574—584, &c.

† The meaning seems to be, instead of a lens, or double convex glass, to try a double concave.

mometers, which shew the heat or coldness of air, so as to throw the moon's rays, by a proper burning-glass, upon the top of such a thermometer, and observe whether the height of the included liquor be altered by the warmth *.

A sixth, to the second.

(6.) Let a burning-glass be tried, with a heat that is not luminous or shining, as that of iron, or stone, heated, but not ignited; boiling water, and the like; and observe whether the heat is increased, as in case of the sun's rays.

A seventh, to the second.

(7.) Let a burning-glass also be tried with common flame.

An eighth, to the third.

(8.) If we are disposed to reckon comets among the meteors, comets are not observed to have any constant or manifest effect in increasing the heat of the seasons, though droughts have been frequently observed to attend them. Bright gleams of light, star-shoots, the opening of the firmament, and the like, appear oftener in winter than in summer, and principally, during intense

* This experiment was tried by Dr. Hook, so far as to shew, that the rays of the moon are neither considerably hot nor cold, but the matter may require to be farther examined, by means of more accurate instruments. See Hook's Lectures of Light, p. 80.

cold, attended with dryness; yet lightning, corruscations, and thunder, seldom happen in the winter, but usually in sultry seasons. And those called falling stars are commonly thought rather to consist of some shining, viscous matter, set on flame, than to be of any strong, fiery nature. But this should be farther enquired into*.

A ninth, to the fourth.

(9.) There are certain corruscations which afford light, but burn not: and these always happen without thunder.

A tenth, to the fifth.

(10.) Eructations and eruptions of flame are found no less in cold countries than in hot ones, as in Iceland and Greenland: and trees in cold countries are sometimes more inflammable, pitchy, and resinous, than in hot ones, as the fir, the pine, &c. But in what situation and nature of soil these kind of eruptions usually happen, has not hitherto been so well examined as to afford a negative to the affirmative†.

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* Consider of the Aurora Borealis, and other appearances of light in the heavens.

† See the accounts of burning mountains, in the Philosophical transactions, the Foreign Journals, Mr. Boyle's Works, &c. And observe that, in all natural enquiries, instances of various kinds, both on the negative and affirmative side, are frequently wanting, or have not been collected and recorded by authors. Whence we see the necessity

An eleventh, to the sixth.

(11.) All flame is constantly hot, in a greater or less degree, so that there is here no negative at all subjoined; and yet they say that the Ignus Fatuus has not much heat, being, perhaps, somewhat like the flame of spirit of wine, which is mild and gentle. But that flame seems still milder which some credible and grave historians relate to have appeared upon the heads of children, without burning or singing them, or only gently playing about their hair. And, it is certain, that there has sometimes been seen a corruscation, without manifest heat, about a horse, sweating in his journey, by night, in clear weather. And loaf sugar, and other things hard candied, being broke or scraped with a knife in the dark, yield light; so does sea-water, forcibly struck in rowing; and the froth of the sea strongly agitated, in a storm, by night*. But as to the flame which the ancient mariners called Cas-

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of a *Sylva*, or particular storehouse of observations and experiments, to be used as the materials in building a serviceable philosophy.

* Consider of the vitreous phosphori, or glass rubbed in the dark, the phosphorus of urine, and all the other kinds of phosphori, putrefied flesh, putrefied fish, diamonds, &c See Mr. Boyle upon phosphori, and several pieces, to the same purpose, in the Philosophical Transactions, French Memoirs, &c.

tor and Pollux, and the moderns term the Brothers, what kind of heat it has is not sufficiently known.

A twelfth, to the seventh.

(12.) Every thing ignited to redness, is perpetually hot, though without flame; and to this affirmative there is no negative subjoined; but what comes nearest to a negative seems to be rotten wood, which shines by night, without heat; and the scales of putrified fish, which also shine in the dark, yet are not hot to the touch; no more than the body of the Glow-worm, or the Lucciole or Light-fly.

A thirteenth, to the eighth.

(13.) It is not sufficiently discovered, as to hot springs, in what situation and nature of the ground they usually flow; and therefore no negative is here subjoined*.

A fourteenth, to the ninth.

(14.) A negative of the nature of fluidity, is subjoined to heated fluids, from the thing itself, for there is no tangible fluid known, than in its own nature remains constantly hot†; but heat is superinduced upon it, for a time only, as an

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* See Becher's Physica Subterranea, and Hoffman's Pieces upon Mineral Waters.

† Therefore, fluidity is not of the nature of heat; or, in other words, fluidity is not essential to heat.

adventitious nature, so that the things most hot, potentially and operatively, as spirit of wine, distilled aromatic oil, oil of vitriol, &c. though they soon prove burning, are cold upon the first touch. And the water of hot springs being received into a vessel, and separated from its fountain, grows cold, like water heated by the fire. It is true, that unctuous bodies are somewhat less cold than water, silk than linen, &c. But this belongs to the tables of the degrees of cold *.

A fifteenth, to the tenth.

(15.) In like manner, a negation of the nature of vapour, such as we find it with us, is subjoined to hot vapours; for exhalations from oily bodies, though easily inflammable, are not perceived hot, unless newly exhaled from the hot body.

A sixteenth, to the tenth.

(16.) So likewise, a negative of the nature of air, is subjoined to hot air; for air is not found hot with us, unless it be shut up, rubbed, or worked together, or manifestly heated by the sun, fire, or other hot body.

A seventeenth, to the eleventh.

(17.) Here we subjoin a negative, from the seasons colder than agrees with the time of the

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* See below, *Aph.* 13.

year, which seasons happen with us upon east and north winds, as the contrary do upon west and south winds. So a tendency to rain, especially in winter, attends a warm season, and a tendency to frost a cold one.

An eighteenth, to the twelfth.

(18.) Here we subjoin a negative, from the air included in the same vaults or caves, during the summer. But the business of included air should be very carefully examined: for, first, it may be well doubted, what is the nature of the air itself, as to heat and cold; since it manifestly receives heat from the impression of the celestial bodies; and cold, perhaps, from the expirations of the earth; and, again, in that called the middle region of the air, from the cold vapours and snow: So that no true judgment can be made of the nature of the air, from the air abroad, and unconfined; but a better when it is shut up. And, here it is necessary to include it in such a vessel, or substance, as may neither communicate heat nor cold, by its own nature, to the air; nor easily receive the impression of the external air. Let the experiment, therefore, be made in an earthen vessel, well covered with several leathers, to defend it from the external air; keeping the vessel well closed for three or four days; then opening it,

to discover the alteration, either by the hand, or a good thermometer, regularly applied *.

A nineteenth; to the thirtieth.

(19.) There is likewise a doubt, whether the warmth in wool, furs, plumage, and the like, proceed from some small degree of heat inherent in them, as they grow; or are thrust out by the animals; or from a certain fat, and unctuous substance, which is of a nature congruous to warmth; or whether, by shutting up, and breaking off the communication of air, as in the foregoing article: for all air, cut off from the continuity of the external air, seems to have something of warmth. Let the experiment, therefore, be tried in shaggy stuffs, made of linen, not of wool, feathers, or silk; which are animal excretions. It is likewise to be observed, that all powders, which manifestly include air, are less cold than the whole substance they were made from: and so we imagine, that all froth, as containing air, is less cold than the liquor it is composed of †.

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* See Mr. Boyle's History of Cold, in init.

† Here, again, consult Mr. Boyle's History of Cold; though certain experiments seem still wanting, to give a fuller information in this case. But we are not here so far to regard the prosecution of the enquiry itself, as to forget

A twentieth; to the fourteenth.

(20.) This has no negative subjoined; for there is nothing found among us, whether tangible, or not tangible, which does not conceive heat, when exposed to the fire; though the bodies differ in this, that some conceive heat sooner, as oil, air, and water; and others slower, as stone and metal: but this belongs to the table of degrees*.

A twenty-first; to the fifteenth.

(21.) There is no other negative subjoined to this instance, but to have it well observed, that no sparks are produced by a flint and steel, or any hard substance, without striking off some small parts from the substance of the stone or metal†; and that the attrition of the air does not produce the sparks as is commonly imagined; whilst the sparks, by the weight of the ignited body, rather tend downwards than upwards; and, upon going out, become a kind of fuliginous matter.

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that the thing proposed is to give an example, of the method of conducting enquiries: though the author has all along contrived to carry on the enquiries themselves, at the same time that he gives examples.

* See below. *Ah.* 13.

† See Dr. Hook's Micrographia.

A twenty-second; to the sixteenth.

(22.) We judge that no negative is producible to this instance, for we find no tangible body but what manifestly grows hot by attrition; whence the ancients imagined, that the celestial bodies had no other means or faculty of growing hot, but by the attrition of the air, in their quick and rapid revolutions. But here it should be farther enquired, whether the bodies discharged out of engines, as bullets out of a gun, do not acquire some degree of heat from the percussion, so as to be found hot after their fall*. But air in motion cools more than it heats, as appears from winds, bellows, &c. For this motion is not so rapid as to excite heat, and is a motion of the whole, not of the particles; whence it is no wonder it should not generate heat.

A twenty-third, to the seventeenth.

(23.) This instance should be diligently en-

* The heat of a leaden bullet, discharged barely by the force of the air, out of a wind-gun, against a metalline plate, so as to become considerably flatted, has been found so great as to burn the fingers, when taken up directly. But it is not certain, that bullets acquire heat barely by moving through the air. This might be commodiously tried with a wind-gun, and a proper instrument for discovering a small degree of heat.

quired into; for all herbs and green and moist vegetables seem to contain some secret heat, though so small as to be imperceptible to the touch in small portions: but when many are joined, and close shut up together, so that their spirit cannot breath out into the air, but the parts must mutually foment and cherish each other, a manifest heat is produced, and sometimes a flame if the matter be disposed thereto*.

A twenty-fourth, to the eighteenth.

(24.) This instance also should be carefully examined; for quick-lime seems to conceive heat, when water is thrown upon it; either by the uniting of the heat, which was before scattered, as in the case of confined vegetables, just now mentioned; or because the fiery spirit is irritated or exasperated by the water, so as to make a conflict and struggle. This matter might be easily determined by using oil instead of water, because oil would serve, as well as water, to unite, but not to irritate, the included spirit. The experiment also should be extended, as well to the ashes and the calxes of different bodies as to the use of different liquors†.

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* See above, Tab. I.

† See Mr. Boyle's Works, *passim*; and the Medicinal Use of Lime-water, in the French Memoirs, An. 1700.

A twenty-fifth to the nineteenth.

(25.) This instance has the negative of all other metals, which are more soft and yielding: thus gold dissolved in aqua regia, lead in aqua fortis, and quicksilver in aqua regia, afford little heat to the touch, in the act of solution *; but silver and copper afford more; tin still more; and iron the most of all: and in the two latter, besides a strong heat, there is also excited a violent ebullition in the dissolution. Whence the heat seems to proceed from the conflict, whilst the acid spirits enter, force into, separate, and divide the parts of the resisting body; but where the body yields easily, there is little heat produced †.

A twenty-sixth to the twentieth.

(26.) To the heat of animals we annex no negative, except that of insects, as was before observed ‡, on account of the smallness of their bodies. For fish, compared with land animals, have rather a degree of heat, than a privation.

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* See the history of Condensation and Rarifaction.

† The other solutions and mixtures, wherein heat is generated, might also be produced as instances to the present purpose. See the chapter of Fire, in Boerhaave's Chemistry.

‡ See above, Tab. I.

But in vegetables and plants there is no degree of heat perceptible to the touch; neither in their tears, nor in their medullary parts, newly laid open. In animals their is found a great diversity of heat, not only in their parts, (as the heat of the heart differs from that of the brain, and this again from that of the external parts;) but also with regard to accidents, as in violent exercise, fevers, &c.

A twenty-seventh, to the twenty-first.

(27.) A negative can scarce be subjoined to this instance, since even the stale excrements of animals have a manifest potential heat; as we see in the manuring of land.

A twenty-eighth, to the twenty-second and twenty-third.

(28.) Such liquors, whether aqueous or oleaginous, as have a great and powerful acrimony, produce the effects of heat, in the separation and burning of bodies, after some time; though at first such liquors were not hot to the touch. And these liquors operate according to the pores of the body, whereto they are applied; for aqua regia dissolves gold, and not silver; aqua fortis dissolves silver, and not gold; but neither of them dissolves glass: and so of liquors *.

* See the chapter of Menstruums, in Boerhaave's Chemistry.

A twenty-ninth, to the twenty-fourth.

(29.) Let trial be made of spirit of wine upon wood, butter, wax, or pitch; whether, by its heat, it will, in some degree, dissolve them: for the twenty-fourth instance shews, that spirit of wine has a power resembling that of heat, in scorching, and therefore let the experiment be made also in liquefaction. Let trial likewise be made by a water-thermometer, with a hollow in the top, on the outside; and pour high rectified spirit of wine into that hollow; then cover it, the better to keep in the heat; and observe whether it makes the water fall or rise *.

A thirtieth, to the twenty-fifth.

(30.) Spices, and plants that prove acrimonious to the palate, are found much hotter when taken internally: let it therefore be considered in what other respects they may have the effect of heat. It is related by sailors, that when large parcels of spices, which have been long kept close confined, come to be opened, those who first take them out, run the hazard of catching fevers, and inflammations of the spirits. Trial, therefore, might be made whether the powders of such spices and herbs would not, like the smoak of fire, dry bacon or fish hung over them.

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* See the chapter of Fire, in Boerhaave's Chemistry.

A thirty-first, to the twenty-sixth.

(31.) There is an acrimony or pugency both in cold things, such as vinegar and oil of vitriol; and in those potentially hot, such as oil of origanum, &c. whence they both alike cause pain in animate bodies, and separate and consume the parts in such as are inanimate. Nor is any negative annexed to this instance. But there is no pain in animals, without a certain sensation of heat.

A thirty-second, to the twenty-seventh.

(32.) There are many actions in common to heat and cold, though they differ greatly in the manner. Thus snow seems to burn soon after it is handled; cold preserves flesh from putrefaction, as well as the fire; and heat makes some bodies shrink as well as cold. But it is more proper to refer these and the like instances to the enquiry about cold*.

13. In the third place, those instances must be brought before the understanding, in which the nature enquired after resides, according to the degree of more or less, whether the comparison of increase or decrease be made in the same subject, or respectively in different subjects; for as the form of a thing, is the very thing itself, or as a thing differs not from the form, other-

* See Mr. Boyle's History of Cold.

wise than appearance does from existence, external from internal, or with respect to man, and with respect to the universe*; it follows, that no nature should be received as a true form, unless it perpetually decrease when the nature decreases; and perpetually increase when the nature increases. The table representing this, we therefore call the Table of Degrees, or the Table of Comparison.

We shall first, therefore, consider such things as to the touch shew no degrees of heat at all, but seem only to have a certain potential heat, or a disposition and preparation towards actual heat; and next proceed to such as are actually hot, or hot to the touch, and observe their different strengths, or degrees.

TABLE III.

A Table of the Degrees of Heat.

(1.) AMONG all the solid and tangible bodies, there is nothing found originally hot in its own nature; no stone, metal, sulphur, or other fossil; no wood, water, or animal carcase: for the water of hot wells seems to be heated acci-

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* These expressions may give us a fuller information as to what the author means by Forms.

dentally, either by flame, or subterraneous fire, such as is thrown up by Ætna, and many other burning mountains; or else by the conflict of bodies, as heat is produced in the dissolutions of iron or tin*. Therefore to the human touch there is no degree of heat in inanimate bodies. And those we have mentioned also differ in degree of heat; for wood is not so cold as iron. But this belongs to the Table of Degrees, for the History of Cold.

(2.) But for potential heats and dispositions to flame, there are numerous inanimate bodies found greatly disposed thereto; such as sulphur, naphtha, and petreol.

(3.) The bodies that are previously heated, as horse-dung in the animal, quick-lime, and perhaps ashes or soot, by the fire, retain some secret remains of their former heat; whence certain digestions, distillations and separations are made of bodies by burying them in horse-dung, and thus heat is excited in quick-lime, by throwing water upon it, as was above observed†.

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* See above, Tab. II. Consider also of the spontaneous heating of Marcasites with water; iron filings and sulphur, moistened with water; and other instances of this nature.

† Tab. I. and Tab. II.

(4.) Among vegetables there is no plant, or part of a plant, whether the excreted tear, or internal pitch, found hot to the human touch; but green plants, as above instanced, become hot by pressure; and some vegetables are found hot, others cold, to the internal touch, viz. to the palate or stomach, or even to the external parts, after continuing applied for some time, as we see in plaisters and unguents*.

(5.) There is nothing found hot to the human touch in the parts of animals after death, or after separation from the body. Even horse-dung retains not its heat unless it be pressed together and buried; yet all dung seems to have a potential heat, as appears from composts and manuring. In like manner, the carcasses of animals have a latent and potential heat, insomuch that in the church-yards where burials are frequent, the earth collects a certain heat, which consumes a carcass newly laid in it, much sooner than mere earth†. And it is reported that the people of the east have a certain fine, soft cloth,

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* Thus the *Emp. Epispastic. Emp. Stomachic. magistral. Emp. è Cymino. Ung. Martiat. Ung. Mastichin.* &c. are heating; and *Emp. de Ranis cum Mercurio, Emp. è Cicuta; Ung. Nutritum, Ung. Populneum,* &c. are cooling.

† Is the fact sufficiently verified?

made of birds feathers, which by its native heat will dissolve butter gently wrapt up therein*.

(6.) Those things that mend land, such as dungs of all sorts†, chalk, sea-sand, salt, &c. have some disposition to heat‡.

(7.) All putrefaction is attended with some small tendency to heat, though not so much as to be perceived by the touch§; for neither those things, which when putrefied, turn to animals, as flesh, cheese, &c. are found hot to the touch, nor rotten wood that shines in the dark; but heat sometimes discovers itself in putrefactions by highly fetid and abominable odours‖.

(8.) The first degree of heat, therefore, of those things which feel hot to the human touch, seems to be that of animals, which has no very great extent in its degrees, for the lowest, as in

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* This may require farther confirmation.

† Except that of geese, according to vulgar observation.

‡ But is this disposition greater than that of many things which do not mend land? And, in this light, what is to be said of nitre?

§ Nor, as is said by a thermometer, applied to a putrefying animal carcass, though this may require to be more exactly tried.

‖ The argument seems conclusive; for odours, perhaps, cannot exist without a certain degree of heat. See Boerhaave's Chemistry, under the chapter of Fire; and the Process of Putrefaction. See also Mr. Boyle's Works, *passim*.

insects, is scarce perceptible to the touch, and the highest scarce equals the heat of the sun in hot countries and seasons; nor is it so great but the hand may endure it: though it is related of Constantius and some others, of a very dry habit of body, that they have been so hot in acute fevers as in a manner to burn the hand applied to them *.

(9.) Animals have their heat increased by motion, exercise, wine, high feeding, venery, burning fevers, and by pain.

(10.) Men in the fits of an intermitting fever are first seized with cold and shivering, and soon after grow very hot; but they continue hot from the beginning in burning and pestilential fevers.

(11.) Let farther enquiry be made of the comparative heat in different animals; as fish, quadrupeds, serpents, and birds; and again, in their different species; as in man, the lion, the kite, &c. for according to common opinion, fish have little heat in their inward parts, but birds a great deal, especially pigeons, hawks, and ostriches.

(12.) Farther enquiry should likewise be made as to the comparative heat of the same animal,

* This seems to be no unfrequent case, when inflammatory fevers happen in robust and sanguine constitutions; if by burning the hand be meant a disagreeable or somewhat painful sensation of heat.

in its different parts and limbs, for milk, blood, sperm, and eggs, are found moderately tepid, or less hot than the outward flesh of the creature upon exercise, or when moved, or excited; but it has not hitherto been examined what the degree of heat is in the brain, stomach, heart, &c.

(13.) All animals are externally cold in the winter and cold seasons, but are then thought to be hotter within*.

(14.) The heat of the celestial bodies, even in the hottest countries and hottest times of the year and day, is not able to fire the driest wood, straw, or tinder, unless strengthened by the burning glass, though it may raise a vapour from moist matters†.

(15.) According to the tradition of astronomers, some stars are more, and others less hot. Among the planets, Mars is said to be the hottest, or next to the sun; then Jupiter; and then Venus: but the Moon is supposed to be cold; and Saturn the coldest planet of

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* Suppose, by what is called Antiperistasis; but this does not, perhaps, appear by the thermometer. See Mr. Boyle's History of Cold; and Dr. Boerhaave's Chemistry, under the chapter of Fire.

† The direct rays of the sun are said to be capable of melting lead, in certain climates or even to fire the houses. See Boyle, Abridgm. Vol. III. p. 55, &c.

all. Among the fixed stars, Sirius is supposed the hottest; then Cor Leonis; then the lesser Dog-star, &c.

(16.) The sun proves hotter to us, the nearer he comes to the perpendicular, or zenith; and the same is to be understood of the planets, according to their different degrees of heat. For example, Jupiter proves much hotter to us when he is in Cancer or Leo, than when in Capricorn or Aquarius.

(17.) It is to be supposed that the sun and all the planets heat more in their Perigee, when they are nearest the earth, than in their Apogee, when they are farthest from it; but wherever the sun is at the same time both in its Perigee, and nearest the zenith, it must necessarily be hotter, than where the sun is in its Perigee, but farther distant from the zenith. So that the comparative ascensions of the planets must be here regarded as they approach to, or recede from the perpendicular in different countries.

(18.) The sun and planets are supposed hotter in their appulse to the larger fixed stars. So when the sun is in Leo, it is nearer the Cor Leonis, the Cauda Leonis, Spica Virginis, Sirius and Canicula, than when in Cancer; where yet it is nearer the zenith. And it is to be supposed that those parts of the heavens give the greatest heat, though not perceptible to the

touch, that are fullest of stars, especially stars of the first magnitude.

(19.) The heat of the celestial bodies is increased three ways; viz. (1.) by their perpendicularity; (2.) their nearness of approach, or perigee; and, (3.) by the stars lying thick together.

(20.) There is a very great difference found between the degree of heat in animals, and that of the celestial bodies, as it affects us on the one side; and the mildest flame, all ignited bodies, or even liquors, and the air itself, much heated by the fire, on the other: for the flame of spirit of wine, even though diffused and uncollected, is able to burn straw, linen or paper, which animal heat will not do, nor solar heat, without the assistance of the burning-glass.

(21.) But there are numerous degrees of strength and weakness of heat in flame and bodies ignited, though, as no careful enquiry has been made about them, we are obliged to pass them lightly over. (1.) The flame of spirit of wine seems to be the softest, unless we except the ignes fatui, and the corruscations of sweating animals. (2.) The flame of spirit of wine, we judge, is succeeded by the flame of porous and spongy vegetable; as straw, rushes, and dried leaves, from which the flame of hair or feathers does not greatly differ. (3.) Next to this, perhaps, may follow the flame of wood,

especially such as abounds not in rosin or pitch; but the flame of brush-wood or twigs (which are commonly bound up into faggots) is more gentle than that yielded by the trunks and roots of trees, as is found by experience in the furnace for melting iron from the stone, where small wood is of little service. (4.) Next to this comes, in our estimation, the flame of oil, tallow, wax, and the like unctuous and fat bodies, which have no great acrimony. (5.) But a stronger heat is found in pitch and rosin. And (6.) a still stronger in sulphur, camphire, naphtha, petreol, and salts, after their crude matter is discharged; and in the composition hereof, as in gun-powder and wild-fire of different kinds, which have so stubborn a heat that water can hardly extinguish it.

(22.) (7.) We suppose also, that the flame arising from certain kinds of imperfect metals is exceeding strong and sharp *; but of this a farther enquiry should be made.

(23.) (8.) The flame of strong lightning seems to exceed all the former, so as sometimes to melt perfect iron itself into drops, which those other flames cannot do.

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* As in making the common regulus of antimony, prince's metal, with zink and copper, and many other metallurgical experiments.

(24.) (9.) There are also different degrees of heat in bodies ignited, though these likewise have not hitherto been diligently enquired into. The weakest heat of this kind we take to be, (1.) that of tinder, and the match used in the firing of great guns; after which come (2.) ignited char-coal, pit-coal, brick, &c. but (3.) the hottest of all ignited bodies seem to be metals; as copper, iron, &c. though farther enquiry should be made about them.

(25.) Some ignited bodies are found much hotter than some flames; for ignited iron is much more hot and burning than the flame of spirit of wine.

(26.) There are also some bodies, which, though unignited, and only heated by the fire, such as boiling water, and air pent up in reverberatory furnaces, are hotter than many flames and bodies ignited.

(27.) Motion increases heat, as appears by bellows and blow-pipes; insomuch that the harder metals will not melt in a dead or still fire that is not animated by the blast.

(28.) Let trial be made with the burning-glass; for, as I remember, if the glass be held, for example, at the distance of ten inches from a combustible body, it will not then burn so much, as if it be first placed at the distance of five inches, and then be gradually and slowly

drawn away to the distance of ten, though the collection and cone of rays remain the same, the bare motion thus increasing the effect of the heat.

(29.) Those conflagrations which happen in the time of a strong wind, are thought to advance faster towards the wind than from it, because the flame recoils swifter when the wind slackens, than it advances forward when the wind drives it.

(30.) Flame proves strong, vigorous, and generative, only when it finds some cavity wherein to move and play and exert itself, except the flatulent flame of gun-powder, and the like, where compression and confinement increase its force.

(31.) The anvil grows very hot by the repeated strokes of the hammer, so that if it were thin, we judge it might be ignited by strong and successive strokes; but this remains to be tried*.

(32.) But in such ignited bodies as are porous, and afford space enough for the fire to move in,

* It is certain, that a piece of iron has, by various strokes of the hammer, nimbly repeated, been soon made to appear red hot; insomuch that this is sometimes accounted no bad expedient for lighting a fire among nailors, and those workers in iron who use a quick hammer. See Dr. Hook's Lectures of Light, p. 117.

if the fire's motion be curbed by a strong compression, the fire is immediately extinguished; as when tinder, or the burning wick of a lamp, a flaming coal, &c. is squeezed by the foot, or the like, upon which the effects of the fire presently cease.

(33.) The approach of a hot body increases heat according to the degree of nearness; and the case is the same in light, for the nearer an object is placed to the light the more visible it becomes.

(34.) The uniting of different heats increase heat, unless the bodies come to be mixed, for a great fire and a small one being near each other, somewhat increase each others heat; but warm water put into boiling water cools it.

(35.) The continuance of heat in a body increases heat; for heat thus perpetually flying off is mixed with the heat before existing, so as to multiply the heat. Thus a fire kept up for half an hour, does not heat the room so much, as if the same fire were kept up for an hour. But this is not the case in light; for a lamp does not enlighten a room more by long continuing to burn, than when it is first lighted.

(36.) External cold increases heat; for we find that fire scorches violently in frosty weather. This, we conceive, happens not only from the heat being shut up and contracted, which is

kind of union*, but also by irritation. Thus when the air, or any elastic body, is violently compressed or bent, it recoils not only to the point it was forced from, but beyond it. Therefore let careful trial be made, by placing some combustible material in flame, to shew whether it will not be burnt sooner on the surface, than in the midst of the flame†.

(37.) There are many degrees in the reception of heat. And first it is to be observed, how small and slender a heat may somewhat change, and a little warm those bodies which are least of all susceptible of heat. For the heat of the hand will warm a bullet of lead or any other metal, held for a while in it; so easily, and in all cases, is heat transmitted, and excited, though the body to appearance seems no way changed.

(38.) But of all bodies that we know, air the easiest receives and communicates heat, as appears by weather-glasses, which are made thus. Take a bellied glass, with a long and slender stem, and invert the nib of it into another glass vessel of water, so that the aperture of the first glass may touch the bottom of the second, whilst the stem is supported a little by the mouth of

* See above, §. (34.)

† See Dr. Hook's Lectures of Light; and Discourse of Comets. See also hereafter, *Aph.* 20.

the under glass, so as to stand, without having its orifice entirely closed. And the better to effect this, apply some wax to the mouth of the under receiving glass, but so as not to stop this up neither. Before the bellied glass is inverted into the other, let its belly be heated at the fire; and when placed as above-mentioned, the air, which was dilated by the heating, will contract itself (after the adventitious heat is gone) to an equal dimension with that of the external or common air, at the time, and raise the water upwards in the same proportion. And now, when a scale of degrees, made upon a long slip of paper, is pasted along the stem, according as the weather grows hotter or colder, the included air will contract with the cold, and expand with the heat, and shew the effect by the ascent of the water when the air is contracted, and by the descent thereof when the air is expanded. But the sensibility of the air, in respect of heat and cold, is so subtile and exquisite, as far to exceed the perception of the human touch; insomuch, that a ray of the sun, or the warmth of a man's breath, much more the heat of one's hand, placed upon the top of the glass, will immediately cause the water manifestly to sink *. Though we conceive

* For the improvement of thermometers, see Mr. Boyle's History of Cold, and Dr. Hook's Works, *passim*. See also Dr. Boerhaave's Chemistry.

that the spirit of animals has a still more exquisite sense of heat and cold, unless it be obstructed and blunted by the grosser matter of their bodies.

(39.) Next to air, we judge those bodies to be most sensible of heat which are newly changed and compressed by cold; such as, 1. snow and ice, for these begin to relent and dissolve with any gentle heat; 2. after these, perhaps, comes quicksilver; after this comes, 3. fat bodies, such as oil, butter, &c.; 4. wood; 5. water; 6. and lastly, stones and metals, which do not easily heat, especially within, though they very long retain the heat they have once received; so that a red-hot brick, stone, or piece of iron, quenched in a bason of cold water, retain such a heat, for some minutes after, that they cannot be handled.

(40.) The less bulk a body is of, the sooner it conceives heat, by the approach of a hot substance, which shews that all heat with us is in a manner averse to tangible bodies*.

(41.) Heat, to the sense and human touch, is an undetermined, relative thing; so that warm water shall seem hot to a cold hand, and cold if the hand be hot†.

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* As being readiest communicated in the smallest, and perhaps the most rarified bodies.

† See Mr. Boyle's History of Cold, *in init*.

14. How unprovided we at present are in natural and experimental history, may be easily observed from hence, that in the preceding tables we are frequently obliged to direct experiments, and farther enquiry to be made into particulars; and that instead of approved history, and such instances as may be depended upon, we are sometimes driven to insert traditions and relations, though we do this always with a manifest doubting of their truth and authority*.

15. The office and use of these three tables is to present a view of instances to the understanding. And when this view is procured, the business of induction is to be put in practice. For, upon a particular and general view of all the instances, such a nature is to be discovered as may be continually present or absent, and always increase and decrease with that nature; and, as we above laid down, limit the more common nature†. But if the mind should attempt to do this affirmatively from the first, as it uses to do when left to itself, there presently rise up phan-

* Little progress can be expected in philosophy, and the sciences, till an ample and exact History of Nature and Art is procured, out of which, as out of a storehouse, particulars should be drawn, as they come to be wanted, in all enquiries.

† See above, *Part* II. *Aph.* 4.

toms and notional hypotheses, ill defined, and Axioms that daily require a mending hand, unless, after the custom of the schools, we would contend for falsehood; though doubtless these Axioms would be better or worse, according to the powers and strength of the understanding that formed them. God, the great Giver and Creator of forms, doubtless knows them by immediate affirmation, at the first glance of the understanding; and so, perhaps, may angels, and such sublime intelligences; but this far exceeds the human capacity, which can only first proceed by negatives; and lastly, after a perfect exclusion, end in affirmatives.

16. We must, therefore, make a perfect resolution and separation of nature, not by fire, but by the mind; which is, as it were, the divine fire. And thus the first work of genuine induction, in the discovery of forms, is to throw out, or exclude, such particular natures as are not found in any instance where the given nature is present, or such as are found in any instance where that nature is absent; and again, such are found to increase in any instance when the given nature decreases, or to decrease when that nature increases. And then, after this rejection and exclusion is duly made, the affirmative, solid, true, and well defined form, will remain as the result of the operation, whilst

the volatile opinions go off in fume*. And this is easily expressed in words, but the thing itself cannot be come at without numerous turnings and windings. We will, however, endeavour not to omit any one step that conduces to the end.

17. But here a general caution, or perpetual admonition must be given, lest, as we seem to attribute so much to forms, what we say of them should be understood of such forms as men have hitherto accustomed themselves to consider†.

For, (1.) we do not at present speak of compound forms, that is, combinations of simple natures, according to the common course of the universe, as the form of an eagle, a lion, a rose, gold, &c. the time of treating which will be when we come to concealed processes and secret textures, and the discovery of them, as they are

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* The metaphor seems taken from the operation of testing, or the way of refining, or assaying gold and silver ores, with lead; which very appositely illustrates this method of induction; the lead, some way or other, carrying off with it whatever is volatile or vitrifiable, and not true gold or silver. For thus, the proper set of instances being procured, (like an ore wherein the nobler metals are contained) they are tried by induction as in the furnace, so as to leave the true form behind, like a brill of gold or silver, upon the test.

† Viz. The peripatetic, or notional forms, &c.

found in those called substances, or concrete natures*.

(2.) And even in the case of simple natures, we must not be understood to mean any abstract forms, or ideas, that are either undetermined, or ill determined in matter. For when we speak of forms, we mean no other than those laws and determinations of pure action, which regulate and constitute any simple nature, as heat, light, and gravity, in all kinds of matter susceptible thereof; and therefore the form of heat, or the form of light, is the same thing as the law of heat, or the law of light, for we perpetually keep close to practice, and things themselves†; and therefore when we say, for example, in the enquiry into the form of heat, reject tenuity‡, or tenuity is not of the form of heat; It is the same as if we said, Men may superinduce heat, upon a dense body; or, on the other hand, that men may take away heat from a rare one§.

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* See *De Augment. Scientiar.*

† Certainly this caution has not been sufficiently observed, whence many have conceived this Second Part of the Novum Organum to be rather a deep, or, according to the vulgar expression, a metaphysical speculation, than a thing directly tending to operation; or, what it is in reality, with regard to the mind, practice itself.

‡ See below, *Table* IV.

§ It cannot be too well remembered, nor perhaps suf-

(3.) And if any one shall think that our forms have somewhat abstracted in them, because they appear to mix and join together things that are heterogeneous, as the heat of the celestial bodies, and the heat of fire; the fixed redness of a rose, and the apparent redness of the rainbow, the opal, or the diamond; death by drowning, and death by burning, stabbing,, the apoplexy, consumption, &c. which, though very dissimilar, we make to agree in the nature of heat, redness, death, &c. he must remember, that his own understanding is held and detained by custom, things in the gross, and opinions. For it is certain, that the things above-mentioned, however heterogeneous and foreign they may seem, agree in the form, or law, that ordains heat, redness, and death. Nor can the human power be otherwise freed, and set at liberty from the common course of nature, and extended and exalted to new efficients, and new ways of working, than by disclosing and investigating this kind of forms. But after treating of this unity of nature*, which is a most capital thing, we shall

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ficiently inculcated, that theory and practice, in the mind, are but one and the same thing; or differ no more, in any respect, than as cause and effect, or rule and work.

* See above, *Part* II. *Aph.* 3.

proceed to the true divisions and paths of nature, as well the ordinary as internal*.

18. But we are next to propose an example of the exclusion or rejection of those natures which, by the tables of view, are found not to be of the form of heat, admonishing, by the way, that not only each table suffices for the rejection of any nature, but also every single instance contained in each table; for it is manifest, from what goes before†, that any one contradictory instance destroys the notion of form. However, for clearness sake, we sometimes double or repeat the exclusion, the better to demonstrate the use of the tables.

TABLE IV.

An Example of the Exclusion or Rejection of Natures, from the Form of Heat.

(1.) BY the sun's rays, reject elementary, or terrestrial nature, from the form of heat‡.

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* See below, *Sect.* II. *passim.*

† See in particular, *Aph.* 4, 16, &c.

‡ That is, since the sun's rays are found to be hot, a terrestrial or elementary nature is not of the form of heat, or heat is not confined to terrestrial or elementary bodies. See below, *Aph.* 19. and 20. (31.)

(2.) By common fire, and principally by the subterraneal fires, which are very remote, and entirely cut off from the celestial rays, reject celestial nature.

(3.) By the heating of all kinds of bodies, whether mineral, vegetable, or animal; whether water, oil, air, &c. upon the bare approach of fire, or other hot body, reject all variety, or subtile texture of bodies.

(4.) By iron, and ignited metals, which heat other bodies, without loss of weight or substance, reject communication, or mixture of any other hot substance.

(5.) By hot water, hot air, metals, and other solid bodies that will receive heat without ignition, reject light and splendor.

(6.) By the rays of the moon and stars, except the sun, again reject light and splendor.

(7.) By the comparison of ignited iron, and the flame of spirit of wine, whence the iron appears to be hotter and less lucid, but the flame of the spirit more lucid and less hot, again reject light and splendor.

(8.) By gold and other ignited metals, which are very dense in their entire substance, reject tenuity.

(9.) By air, which is generally found cold, and yet remains thin and subtile, again reject tenuity.

(10.) By ignited iron, which swells not in bulk, but remains of the same dimension to appearance*, reject local, or expansive motion in the whole.

(11.) By the dilatation of the air in weather-glasses, and the like, where the air is evidently moved locally, and expansively, without becoming manifestly hotter, again reject local, or expansive motion in the whole.

(12.) By the facility wherewith all bodies are warmed, without destruction, or remarkable alteration, reject destruction, and great communication of any new nature.

(13.) By the similitude and conformity of certain operations, performed both by cold and heat, reject as well expansive, as contractive motion in the whole.

(14.) By fire following heat upon the attrition of bodies, reject principal nature; that is, a positive nature, not caused by a precedent one.

N. B. There are also other natures to be excluded, for our tables are not designed as perfect, but only as examples.

N. B. Neither all, nor any one of the preceding natures, are of the form of heat; so that

* Though not upon exact trials. Let it be considered how justly this expansion, or rarifaction of the whole body, has been made by some the universal criterion, or form of heat. See below, *Aph.* 20. (8.) (15.) (13.) (26.)

men, in their practices upon heat, are freed from the necessity of introducing any, or all of them *.

19. The business of exclusion lays the foundations for a genuine induction, which, however, is not perfected till it terminates in the affirmative; but our exclusion is by no means perfect, nor can it possibly be so at first. For exclusion, as we plainly see, is the rejection of simple natures; and if we have hitherto no just and true notion of simple natures, how can the business of exclusion be rectified? But some of the above-mentioned notions, as those of elementary nature, celestial nature, and tenuity †, are vague and ill defined. Wherefore, not forgetting how great a task we have undertaken; viz. no less than that of rendering the human understanding equal to things and nature, we are by no means to stop here, but must proceed to invent and afford greater helps to the mind. For,

* Observe how this investigation of forms corresponds to a just practical rule, (for producing unlimited effects) laid down above, under *Aph.* 4. (5. and 6.) If due attention has been used, the reader will now begin to see the scene open, and find cause to expect more considerable things from the human power and knowledge, than have hitherto been produced by any philosophers unacquainted with the true method of enquiring into nature, by the means of this new engine of the mind.

† See *Table* IV.

doubtless, in the interpretation of nature, the mind is to be so prepared and formed, that it may both rest upon proper degrees of certainty, and yet conceive, especially in the beginning, that the things which are present have a great dependance upon those behind*.

20. And yet, because truth will sooner emerge from error, than from confusion, we judge it useful to allow the understanding, after having made and considered the three tables of preparatory view, in the manner we have laid them down, to apply itself, and attempt the business of interpreting nature in the affirmative, on the strength of the instances contained in these tables, and such as may be otherwise procured. And this kind of attempt we call a permission to the understanding, the rudiments of interpretation, or the first vintage of enquiry*.

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* See above, *Part* I. *Aph.* 130. *ad finem.*

† The first vintage, in wine countries, produces the poorest wines, which they usually distil for brandy, as being not fit to keep, in the form of wines.

TABLE V.

The first Vintage, or Dawn of Doctrine, from the Form of Heat.

(1.) IT appears, from the preceding doctrine, that the form of a thing resides in all the particular instances, wherein the thing resides, otherwise it would not be a form*; and therefore no contradictory instance hereof can be given.

(2.) Yet the form is found much more conspicuous in some instances, than in others, especially in those where the nature of the form is less confined, obstructed, and subdued, by other natures; and this kind of instances we call shining, or glaring instances†. And thus we now proceed to reap the first fruits of our enquiry after the form of heat, in the way of example.

(3.) In all instances, considered as well separately as collectively, the nature whose limitation is heat, appears to be motion‡. This we find chiefly in flame, which is in perpetual motion; and in hot, or boiling liquors, which are also in a continual agitation. It likewise appears, by the sharpness or increase of the heat, caused by motion, as in bellows and blasts§;

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* See above, *Part* II. *Aph.* 4.

† See below, *Sect.* II. *Aph.* 24.

‡ See above, *Aph.* 4.

§ See Tab. III. Instance 27.

and again, in other kinds of motion, for which see the twenty-eighth and thirty-first instances of the third table. It is found also in the extinguishing of fire, and heat, by all strong compression, which checks and puts a stop to motion. See the thirtieth and thirty-second instances of the third table. Again, it is shewn by this, that all bodies are destroyed, or at least remarkably altered, by all kinds of fire, or strong or vehement heat. And from hence it plainly appears, that heat causes a tumult, disturbance, and brisk or eager motion in the internal parts of bodies, which gradually tends to a dissolution of the body.

(4.) What we have thus said of motion, is to be understood of it as of a genus*, with regard to heat, and not as if heat generated motion, or as if motion generated heat, though this may be true in some cases; but the meaning is, that heat itself, or the very existence of heat, is motion, and nothing else†; though motion, limited by the differences, we shall presently subjoin, after giving a few cautions for the avoiding of ambiguity.

(5.) Heat to the sense is a relative thing, that regards mankind, not the universe, and is justly assigned only as the effect of heat upon the ani-

* Or universal kind. † See above, *Part* II. *Aph.* 4.

mal spirit or mind, being in itself an indeterminate thing; for the same body, according as the sense is predisposed, may give the perception as well of heat as of cold, as appears by the forty-first instance of the third table.

(6.) But the communication, or transitive nature of heat, whereby one body conceives heat upon being applied to another that is hot, must not be confounded with the form of heat; for heat is one thing, and heating another. Heat is produced by the motion of attrition, without any heat preceding that motion; whence heating is excluded from the form of heat. And when heat is produced by the approach of a hot body, this does not proceed from the form of heat, but depends entirely upon a higher and more common nature*; viz. upon the nature of communication, assimilation, or self-multiplication, which demands a separate enquiry.

(7.) The notion of fire is vulgar, and composed of heat and splendor, as existing in some one thing; for example, in common flame, and bodies ignited, or made red-hot. And having thus

* This is a subtile and curious distinction. The meaning appears to be, that, when heat is once produced by the existence of its form, that is, by a particular motion, it propagates itself, not by means of its form, but by the principle of assimilation, or self-multiplication. See Sir Isaac Newton upon the Heat of the Comets. Princip. Lib. III. p. 467, &c.

removed all ambiguities, we at length come to the true differences, which limitate motion, so as to constitute it the form of heat*.

I.

(8.) The first difference is this, that heat is an expansive motion, whereby a body endeavours to dilate itself, and stretch into a greater sphere, or dimension, than it before possessed†. And this difference appears principally in flame, where the smoak, or unctuous matter, manifestly dilates and opens itself into flame. It appears likewise in all boiling liquors, which manifestly swell, rise up, bubble, and carry on their process of expansion, till they change into a much more rarified body than the liquors themselves, as for example, into vapour, flame, or air.

(9.) It appears likewise in wood, and all combustible bodies, which sometimes sweat, but always evaporate.

(10.) It appears again, in the melting of metals, which being of a very compact substance, do not easily swell and dilate; yet their spirit‡,

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* See *Part* II. *Aph.* 4.

† Observe, that this does not contradict, but coincide with the tenth and eleventh instances of the fourth table, though the correspondence may not, perhaps, appear at first sight.

‡ See the *Sylva Sylvarum*.

after being itself dilated, and endeavouring at a still greater extension, forces and agitates the more gross parts into a fluid state; and if the heat be greatly increased, it resolves, volatizes, and drives off much of their substance.

(11.) It appears also in iron and stone, which at least are softened, if not liquified and fused by fire. So likewise rods of wood become flexible, by being somewhat heated in hot ashes.

(12.) But this motion is best perceived in air, which continually and manifestly dilates itself, with a small heat, according to the thirty-eighth instance of the third table *.

(13.) Again, it appears from the contrary nature of cold, for cold contracts all bodies, and makes them shrink, insomuch that nails have dropt out of walls, and brass vessels have cracked, through cold. So likewise glass heated, and suddenly brought into the cold, cracks and flies to pieces. Air contracts itself even upon lightly cooling, as appears by the thirty-eighth instance of the third table †. But the full consi-

* Neither does this contradict the eleventh instance of the fourth table. The assigning of these differences is a particular work of the understanding, employed solely in adjusting and reconciling the instances of the preceding tables, without distraction or avocation.

† It should here be remembered, that water expands in freezing, for ice is specifically heavier than the water that

deration of these particulars belongs to the enquiry of cold.

(14.) And it is no wonder that cold and heat should perform many actions in common, according to the thirty-second instance of the second table, because two of the differences, which we shall presently mention, belong to both natures, though, in the present difference, their actions are diametrically opposite; for heat gives an expansive, and cold a contractive motion.

II.

(15.) The second difference is a modification of the former, and depends upon this, that heat is an expansive motion, or a motion towards the circumference; but with this law, that at the same time it rises upwards. And we cannot doubt but there are many mixed motions, as that of an arrow, for example, which revolves in going forwards, and advances by revolving. And, in like manner, the motion of heat is, at the same time, both expansive and upwards.

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affords it. How this happens, the Author explains in the History of Condensation and rarifaction. But, perhaps, if the water be very well purged of its air, before it is froze, the ice will not be lighter than water. See Boerhaave's Chemistry, under the Chapters of Fire and Water. See also Mr. Hawksbee's Physico-Mechanical Experiments, p. 257.

(16.) This difference is perceived by heating one end of an iron rod, held perpendicularly in the fire, in which posture it will burn the hand much sooner at the other end than if it were held aslope, or downwards.

(17.) This difference also appears from distillation *per descensum*, or the method of distilling downwards, (which is practised upon curious flowers, whose odour is easily lost) viz. by applying the fire, not below, but above the subject, that it may scorch the less, for not only flame, but all heat tends upwards.

(18.) Let trial be made of this in the contrary nature, that of cold, to find whether cold will not contract bodies by moving downwards; as heat dilates them, by rising upwards. Take, therefore, two iron rods, or two glass tubes, exactly alike; heat them a little, and place a spunge full of water, or a quantity of snow, under the one; and in like manner over the other; for we conceive that rod or tube will cool faster at the farther end where the snow lies at the top, than where it lies at the bottom; contrary to what happens in heat *.

III.

(19.) A third difference is this; that heat is

* See the experiments of the Academie del Cimento at the end; and Mr. Boyle's History of Cold.

not an expansive uniform motion, in respect of the whole*, but expansive in the lesser particles of a body, and at the same time checked, repelled, and reverberated, so as to become an alternative, perpetually shuddering or struggling motion, or action, which is irritated by the reaction of the body†; whence proceeds the violence of fire and heat.

(20.) And this difference appears chiefly in flame and boiling liquors, which continually tremble, swell in their small particles, and again subside.

(21.) It appears also in such bodies as are of too hard a texture to swell, or increase remarkably in bulk, when heated or ignited, as red-hot iron, in which the heat is very intense‡.

(22.) It also appears from hence, that fire burns sharpest in the coldest weather.

(23.) Again, it appears from this, that when the air stretches uniformly and equably in a

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* As when a bladder is distended by blowing into it.

† As when a nail is driven up to the head in a board, and made to shudder and vibrate in its small parts by the stroke of the hammer.

‡ It should seem as if this shuddering action were visible in iron, even though heated below the degree of ignition; for in looking upon such heated iron, the eye receives an odd impression of a particular kind of waving or recurrent motion.

weather-glass, there is no sensible heat perceived. And even confined winds, though they blow and move violently, yet produce no remarkable heat, because the motion is the motion of the whole; without an alternative or shuddering motion in the particles. And to this purpose let trial be made whether flame does not burn sharper on the surface than in the middle.*

(24.) Lastly, it appears from this, that all burning passes through the minute pores of the body burnt, so that the burning undermines, saps, penetrates, and enters, like the points of an infinite number of needles. And hence it is that all acid spirits, if suited to the body they act upon, have the effect of fire, from their dissolving or corroding nature†

(25.) And this difference we now speak of

* This is easily tried in a common candle, where if a piece of packthread, or a splinter of wood, be thrust into the centre of the flame, the point will remain for a while unburnt, whilst the outermost part, in contact both with the flame and air, readily takes fire, and burns away. Hence flame appears to be a kind of film, or conical surface, whose inside is filled with the smoak of the fuel. Let the common instances be here remembered of sealing-wax, &c. smoked by being held too far in the flame of the candle. See Dr. Hook's Lectures of Light; and Boerhaave's Chemistry, under the chapter of Fire.

† See Dr. Hook's Lectures of Light; and Micrographia, *passim*.

is common to the nature of cold, wherein the contractive motion is restrained by the contrary endeavour of expansion, as the expansive motion is checked in heat by the opposite endeavour of contraction. And therefore, whether the parts of a body penetrate from without inwards, or from within outwards, the case is similar, though the force be very unequal; because we have no body here upon the surface of the earth, that is intensely cold*.

IV.

(26.) The fourth difference is a modification of the last, and depends upon this, that the preceding motion of stimulation or penetration be somewhat rapid, or no way sluggish; and also play among such particles as though minute, yet are not extremely fine, but, as it were, of a moderate size†.

(27.) This difference appears upon comparing the effects of fire, and the effects of time or age, which withers, consumes, undermines, and reduces bodies to ashes, as well as fire, or rather much more subtily; but because this kind of motion is exceeding slow, and exercised upon very fine particles, the heat is not perceived.

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* See Tab. I. Instance 27.

† Observe how the author, according to his own rule proceeds to limit the particular motion, which, as a true genius is to constitute the Form of Heat. See above, *Aph.* 4.

(28.) It again appears, upon comparing the dissolutions of iron and gold; for gold dissolves without causing a manifest heat, but iron excites a strong one, though it scarce dissolves quicker than gold, because in gold the menstruum not only enters milder, and more subtily, but the parts of the gold also prove more yielding; whereas in iron, the entrance of the menstruum is violent, and attended with a conflict, the parts of the iron making a much greater resistance.

(29.) Lastly, it appears also, in some measure, from such gangrenes and mortifications of the flesh, as cause no great heat or pain, by reason of the subtilty of the putrefaction*. And let this serve for what we call the first vintage, or an attempt towards interpreting the form of heat, which the understanding makes, as we said, by the way of permission †.

(29.) The fruit of this first vintage, is, in short, the following true definition, or form of heat, as it regards the universe, and not as it is only relative to the human sense: viz. Heat is an expansive, bridled motion, strug-

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* And these kind of gangrenes or mortifications may happen by cold, or by freezing. See Mr. Boyle's History of Cold, *passim*.

† See above, *Aph.* 36. The meaning is, that as men are apt to grow weary of prosecuting enquiries, where they reap no quick advantage, or receive no immediate fruits of

gling in the small particles of bodies. But this expansion is modified; so that whilst it spreads in circumference, it has a greater tendency upwards. It is also modified alternately, or by fits, so as to prove no way sluggish, but vigorous and active *.

(31.) And as to practice, the case is exactly correspondent, and amounts to this; that if in any natural body a motion can be excited, which shall dilate or expand, and again recoil or turn back upon itself, so as that the dilation shall not proceed equably, but partly prevail, and partly be checked, any man may doubtless produce heat; without at all regarding whether the body that is wrought upon be elementary, as they call it, or earthly; or whether it be enriched with a celestial influence; whether it be luminous or opake; rare or dense; locally expanded, or contained within its original dimensions; whether it tend to dissolution, or remain

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their labours, the understanding is permitted to gratify itself by a kind of anticipation, or by making some offer and first attempts at discovering the Forms of Things; but till the enquiry is duly prosecuted, men have no right to pronounce, or even to expect, that the Forms of Things can be perfectly discovered.

* Here we have an instance of a genuine or scientificial Definition, which is no other than the Form or nature of the thing defined; so that the true Definitions are the results of enquiries duly prosecuted, and not those slight arbitrary notions usually called by the name of Definitions.

in its native state; whether it be animal, vegetable, or mineral; whether it be water, oil, air, or any other substance that is susceptible of the foresaid motion*. And heat, in respect of the sense, is the same thing; only with such relations as belong to sense. And this may serve as an example of ours method of Investigating Forms†.

* Hence we are furnished with a farther criterion, or argument, *à posteriori*, that will shew in fact, whether the Form be justly discovered. Thus if we can produce heat in all bodies susceptible thereof, by introducing into them the Motion here described, we shall have a confirmation that this motion is the Form of Heat. And the only exception in practice is, perhaps, Water; for introducing heat into which, by the means of this particular motion, a well adapted mechanical contrivance seems hitherto wanting, though possibly it might with ease be supplied.

† Though this method is here so fully delivered, and promises better things than possibly any other method of enquiry hitherto known, yet it appears strangely to be disregarded. And, certainly, it should seem as if very few were apprized that this method, thoroughly pursued, is an actual demonstration, as justly and properly suited to physics, or indeed to all philosophy, as mathematical demonstration and algebra are to geometry and general mathematics.

END OF VOLUME THE FIRST.

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